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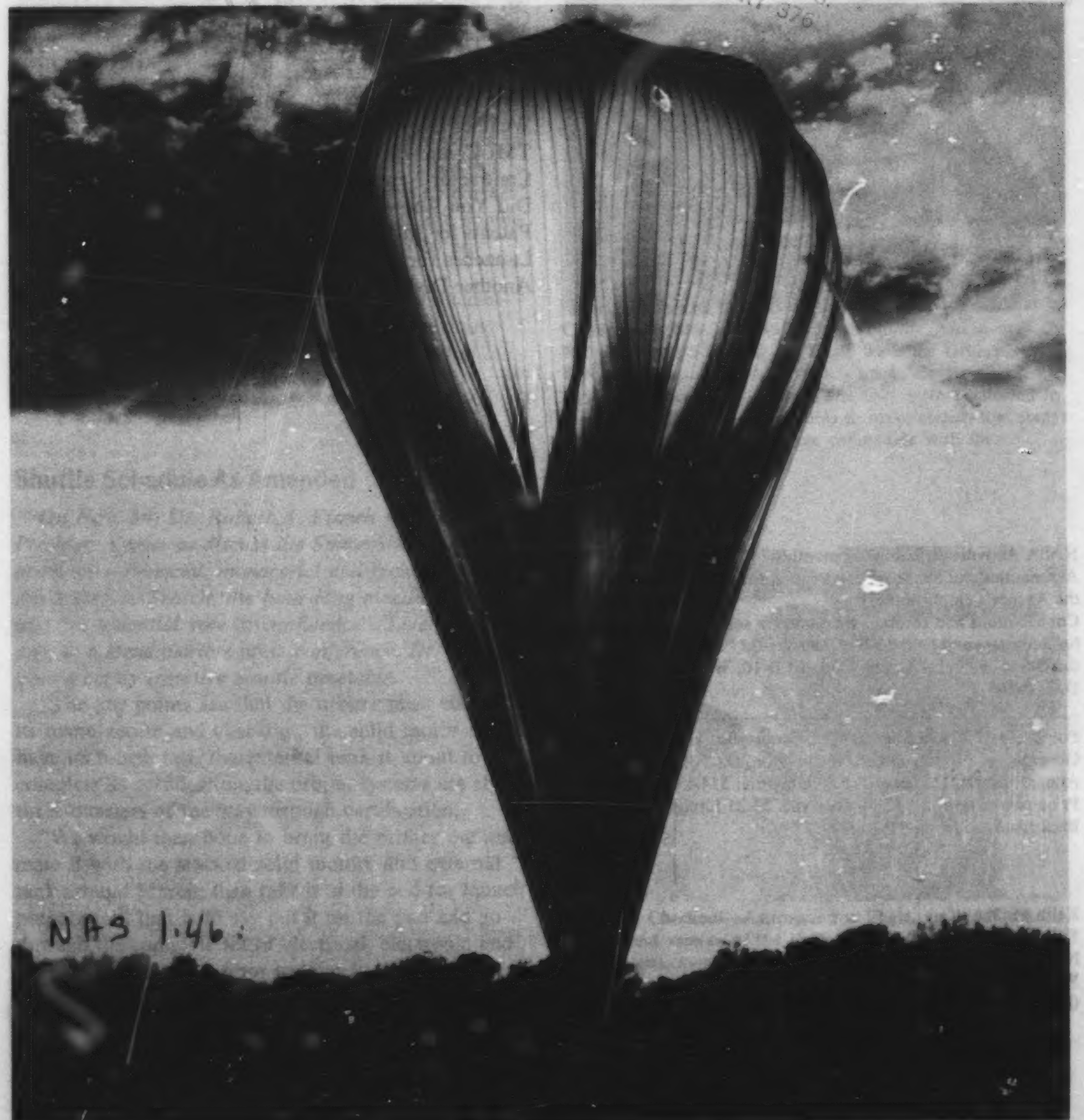

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Cover

Inflated Platform for Discovery—Under West Texas skies, a NASA-sponsored heavy lift balloon nears the final inflation stage before launch. The NASA Balloon Program, managed by the Wallops Flight Center, recently climaxed two years of work in high energy astrophysics, astronomy and upper atmospheric research with an important scientific discovery. A team from New Mexico State University, using a NASA/Wallops high altitude balloon carrying ultrasensitive instruments, found small amounts of antimatter in our galaxy (The Milky Way) in the form of antiprotons. Antimatter has the same characteristics as matter except that its electrons and protons have the opposite electrical charges. The observation was made at an altitude of 34 km over Texas in one of the approximately 120 balloon missions flown by Wallops.

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Wrong Wire Causes Test Failure

The failure of a hydrogen line on the nozzle of a Space Shuttle main engine is attributed to use of improper welding wire. The failure occurred Nov. 4 during an automatic shutdown of a three-engine cluster of test engines at NASA's National Space Technology Laboratories in Bay St. Louis, Miss.

Use of the improper welding wire severely decreased the strength of the weld on a segment of hydrogen line known as the "steerhorn," near the base of the engine nozzle. When the line ruptured an oxygen-rich combustion resulted, extensively damaging the test engine. Two lots of welding wire, designated Inconel 718, are suspect. Investigation of the lots revealed about 20 percent was a weaker weld wire, Inconel 600.

Investigators from Marshall Space Flight Center and Rockwell International's Rocketdyne Division, Canoga Park, Calif., will check all steerhorn welds to determine the possible extent of use of the suspect wire and determine what steps are needed to correct the problem, which NASA noted is *not* in the engine design. Weak welds can easily be detected by an oxalic acid etch test.

Main propulsion system testing resumed successfully on Dec. 17. A stub nozzle, used in previous three-engine cluster tests, was substituted for the engine nozzle used in the Nov. 4 test.

Shuttle Schedule As Amended

On Nov. 14, Dr. Robert A. Frosch met with President Carter to discuss the Space Shuttle and its problems—financial, managerial and technical. According to Frosch, the hour long meeting resulted in a "Presidential vote of confidence". Later in the day, at a Headquarters press conference, Dr. Frosch gave a highly tentative Shuttle timetable:

"The key points are that the orbiter must complete its manufacture and checkout, the solid motor must have its fourth test, the external tank is about to complete its certification, the orbiter systems are about three-quarters of the way through certification.

"We would then hope to bring the orbiter out and mate it with the stacked solid motors and external tank around March; then take it to the pad for launch preparation, that is to say put it on the pad and go through the complete set of electrical, electronic and mechanical checkout prior to launch; some time in May have a test firing, a flight readiness firing, which would be a short firing to check the liquid engines and all systems but not firing the solid rocket boosters; depending on how successful that was, then be able to proceed to launch as early as the end of June. We would say now, I think, that while June is a possible launch date, some time in August, September is a much more likely launch date and what we think most likely to happen, although we are working to June as a schedule matter. It looks as though the principal remaining problems have to do with the certification through testing of the main engine

Contingency Check at KSC—Space Shuttle Astronauts Richard Truly (left) and Joe Engle leave the Orbiter Processing Facility at the Kennedy Space Center after completing escape suit testing. The tests were conducted in the cabin of the orbiter Columbia to make certain that escape suit fittings and harnesses were compatible with the spacecraft ejection seats.

Left Seat Checkout—Astronaut Joe Engle, an Air Force colonel and veteran of the 1977 Space Shuttle approach and landing tests, monitors instruments from the command pilot's seat during ejection escape suite testing in the orbiter.

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systems. My earlier statement applies to that, namely we are having odds and ends of problems, but in a complex system like that engine, all those problems must be cleared up and each such problem leads to some kind of time in order to do that.

"The other comment that the President made with regard to the approach to flight is that as we get close to the flight, he would like to be kept informed of any significant points of progress, change, or difficulty, and that I am to do that either in the normal ways, or if necessary in my judgment, to talk with him directly and personally."

Acting Head of Shuttle Operations Named

Glynn S. Lunney, manager of the Shuttle Payload and Integration Development program at the NASA Johnson Space Center has been named Acting Associate Administrator for Space Transportation System Operations at NASA Headquarters, effective immediately. Lunney, who reports to Deputy Administrator Dr. Alan M. Lovelace, will be instrumental in forming the new office which was established as a result of the recent decision to separate Space Transportation System Acquisition from Operations. He will continue in the assignment until the position of Associate Administrator for STS Operations is filled.

Lunney in Apollo Days—The new Acting Associate Administrator for Space Shuttle Operations, Glynn Lunney, is shown saluting the good work of Mission Control personnel after the successful recovery of the Apollo 13 crew in 1970. A Flight Director at the time, he was later U.S. Technical Director for the Apollo-Soyuz Test Project and more recently, manager of Shuttle Payload and Integration.

Lunney joined NASA in 1959 at the agency's Lewis Research Center; He was part of the Space Task Group at Langley Research Center, Hampton, Va., and moved with that group to Houston when the Manned Spacecraft Center was created. He was a flight director during the Gemini and Apollo manned flight programs and was U.S. Technical Director for the Apollo Soyuz Test Project joint manned mission with the Soviet Union in 1975. Lunney also spent a year at NASA Headquarters in 1976–77 as Deputy Associate Administrator for Space Flight.

Launch the 150th for Delta

The 150th launch of the Delta rocket placed a domestic communications satellite in Earth orbit in early December. The milestone launch by the "workhorse" of NASA's stable of expendable launch vehicles was, fittingly, the last of the decade. Dating back to May 1960, 137 of 149 Delta launches have been successful, a 92 percent success record.

The RCA American Communications 24-channel SATCOM 3 is now missing. It was to have provided television, voice communications and high-speed data transmissions to all 50 states, primarily to serve the cable TV industry. The Delta 3914 launch vehicle boosted the 895-kilogram spacecraft into an elliptical transfer orbit ranging in altitude from 167 kilometers to 35,786 km.

Approximately three days after launch, an apogee kick motor aboard the satellite was fired and the spacecraft was to have entered a geosynchronous orbit 35,786 km above the equator. At this point, it disappeared from the RCA tracking screens, touching off an exhaustive search of near-Earth space.

The Delta project is managed by Goddard Space Flight Center for NASA's Office of Space Transportation System Operations in Washington, The RCA SATCOM system is managed by RCA American Communications, Inc. Launch operations were conducted by the Kennedy Space Center with all launch costs reimbursed by RCA American. RCA Astro-Electronics Division, Princeton, N.J., built the satellite. McDonnell Douglas Co., Huntington Beach, Cal., is prime contractor for the Delta launch vehicle.

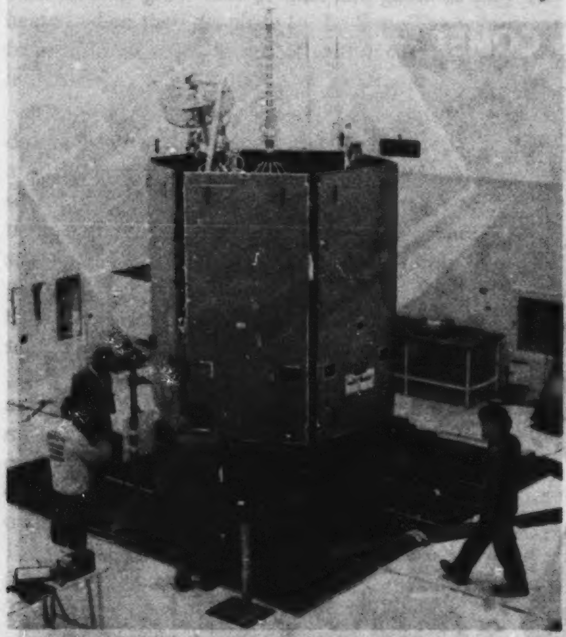
FLTSATCOM Launch Rescheduled

Launch of a FLTSATCOM communications satellite, scheduled for Dec. 4, aboard a NASA Atlas Centaur from Cape Canaveral has been rescheduled for no earlier than Jan. 17.

The delay was prompted by a leak that developed in the high pressure pneumatics system of the Atlas. The leak, detected during routine testing, was traced to a cracked sleeve and nut assembly. The defective sleeve and its associated parts and tubing were removed and replaced. The launch delay has no operational impact on the FLTSATCOM program or service of its Department of Defense users.

Analysis of the sleeve disclosed that it was manufactured from stainless steel which did not meet specifications. An immediate investigation was conducted on all other ⅝-inch sleeves on the launch vehicle and changes were made where necessary.

Additional investigation has revealed that the problem is more widespread. Other size sleeves have been located in stock that do not meet specifications. A detailed plan has been formulated to investigate all appropriate fittings on the launch vehicle.



Destination: Western Pacific—The FLTSATCOM communications satellite is checked over on its way to becoming the third in a Department of Defense series. Launch of the FLTSATCOM, slated for a geostationary orbit over the Pacific Ocean, was delayed in December by technical problems with the launch vehicle. The spacecraft has a design life of five years.

New Thrust in Space Communications

A new, five-year development effort aimed at retaining U.S. world leadership in satellite communications research and technology has been initiated by NASA with lead responsibility for the program assigned to its Lewis Research Center in Cleveland. Lewis will work closely with private industry, the Department of Defense and other NASA Centers on projects which could culminate in the development and launch of a sophisticated communications satellite in 1985 or 1986.

General objective of the program is to spur more effective and increased use of the radio frequency spectrum at the geostationary orbit level, approximately 35,900 kilometers above the Earth.

Another major goal is to develop technology that will provide for lower space communications service costs and catalyze new and innovative services for the public good. An example of the latter would be high-speed, electronic mail services.

Advanced technical studies, already underway at Lewis in support of the new program, are focusing on feasibility of high-technology satellites employing multi-beam antennas, on-board signal processing and switching, high-power transmitters using both solid state and traveling wave tube amplifiers, and solid state low-noise amplifiers. From these studies may emerge a space communications system with the capability of pinpointing transmissions almost anywhere in the country regardless of population size or electronic sophistication.

The Communications Technology Satellite, a joint effort of the United States and Canada, was a Lewis-managed program (for the U.S. portion) which kept the center active in communications technology during a period after 1973 when NASA was withdrawing from communications research and development.

The U.S.-Canadian satellite provided more than three years of space communications experimentation in the use of interactive color television, voice and data transmissions for a host of educational, business, medical and public service programs.

"NASA had phased down its satellite communications technology work in 1973 because of budget pressures and the strong capabilities present in the private sector," explained Daniel J. Shramo, Lewis Director of Space Applications.

"In the intervening years, the communications industry made exemplary progress in advancing the state of the art. The improvements included increasing the number of circuits per satellite, decreasing satellite weight per channel and improvements in antenna performance.

"In 1978 a number of activities were conducted to determine whether NASA should re-enter satellite communications R & D. NASA itself intensively reviewed the state of technology in satellite communications, investigating possible areas where federal assistance would sustain perceived growth expectations.

"After a number of NASA centers had prepared independent assessments, an inter-center team developed a five-year action plan which was subsequently reviewed with major corporations dealing in communications systems and services, with NASA advisory committees and with related other government agencies. All of the re-examination led to the Lewis assignment to assume the lead NASA role in a new effort."

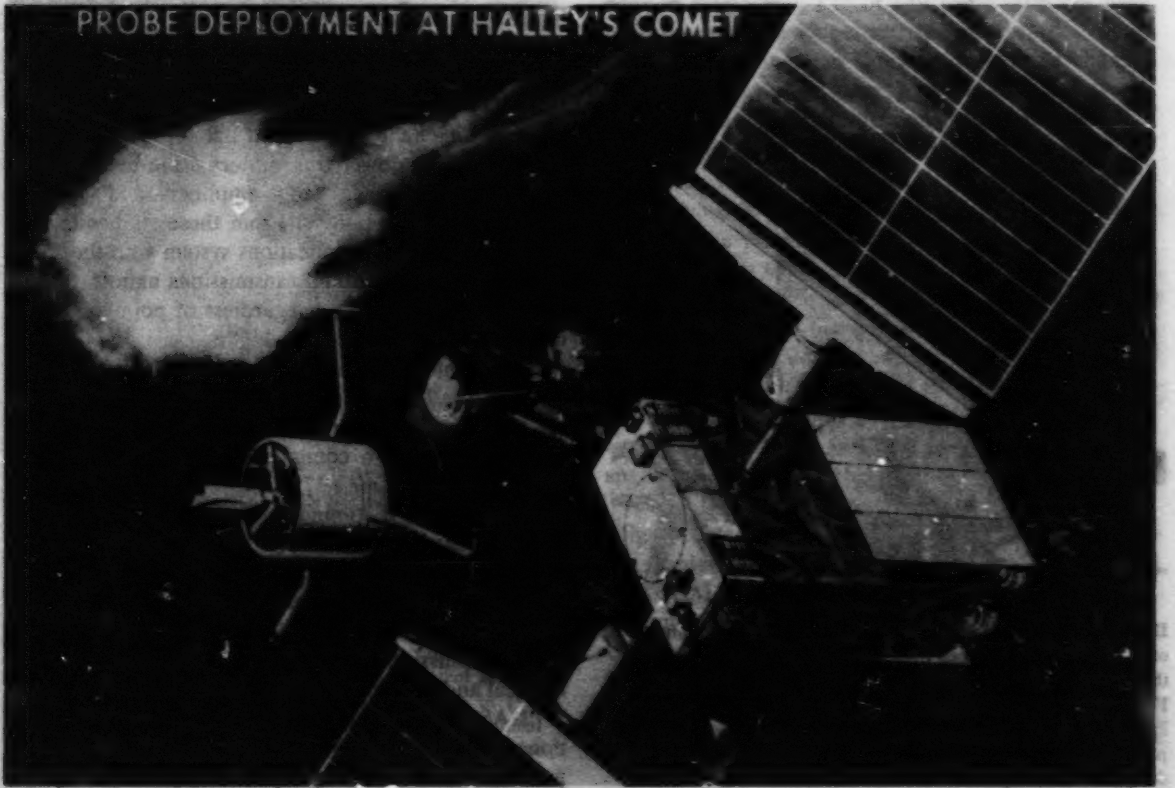
Journey to Two Comets

In cooperation with the European Space Agency, NASA is asking scientists to propose experiments for a planned international mission to two comets—Halley and Tempel 2, the total journey to span four years and cover more than 2.5 billion kilometers.

Utilizing solar electric propulsion engines for the first time in deep space, the spacecraft would fly past Halley's Comet in 1985, release an instrumented probe toward the comet and then go on to encounter Tempel 2 in 1988 and fly side by side with it for a year or more as Tempel 2 circles past the Sun.

Closeup pictures and other scientific information returned by the spacecraft could add significantly to our knowledge about comets, which in turn may shed more light on the origin and evolution of the solar system.

NASA emphasized that the project has not yet been approved but that early selection of scientific participants and investigations is required for a prompt start if approval is granted. Under current plans, NASA will be responsible for the launching, rendezvous spacecraft system and mission operations.


PROBE DEPLOYMENT AT HALLEY'S COMET

The European Space Agency, a consortium of 11 nations, will be responsible for the Halley probe system. The combined scientific payload will be shared by scientists throughout the world.

The proposed mission has three major science objectives:

- To determine the chemical and physical nature of the comet's nuclei.
- To characterize the chemical and physical nature of the comas, the gases and dust which surround the nuclei when the comets approach the Sun.
- And to determine the nature of the comets' tails.

Instruments on the Halley probe and the rendezvous spacecraft will sense the comets remotely as well as collect dust and gases for onboard analysis.

Comets are relatively small bodies circling the Sun in orbits of widely different periods and distances. They are believed to be composed of loose mixtures of water ice, frozen methane, ammonia, carbon dioxide and other gases, with bits of cosmic dust, rock and sand. The combined nucleus and coma make up the head of the comet, which may grow from 2,000 to 200,000 km or more across as it approaches the Sun. Comets grow tails of dust and gases as they are heated when they get close to the Sun. The tails range from millions to hundreds of millions of miles in length.

The opportunity to make close visits to two different types of comets is ideal for the scientists who are trying to understand these "mavericks of the solar system." Because comets spend most of their time far from the Sun—in a very cold corner of the solar system—their original material is believed to be preserved as if it were in a deep freeze. By sampling this material, scientists hope to unlock some of the secrets surrounding the formation of the solar system.

Since comets can be quite different in their chemical and physical characteristics, it is important to sample more than one type. Among large highly active comets which display the full range of phenomena, only Halley has a predictable orbit. It will make its once-every-76-years appearance during the winter of 1985–86. Accordingly, the mission contemplates a flyby of this comet which will not be seen again until 2061.

Unlike Halley, Tempel 2 is smaller and relatively stable. It is typical of a class of comets known as short-period comets which are easier to visit by a spacecraft but exhibit less active phenomena.

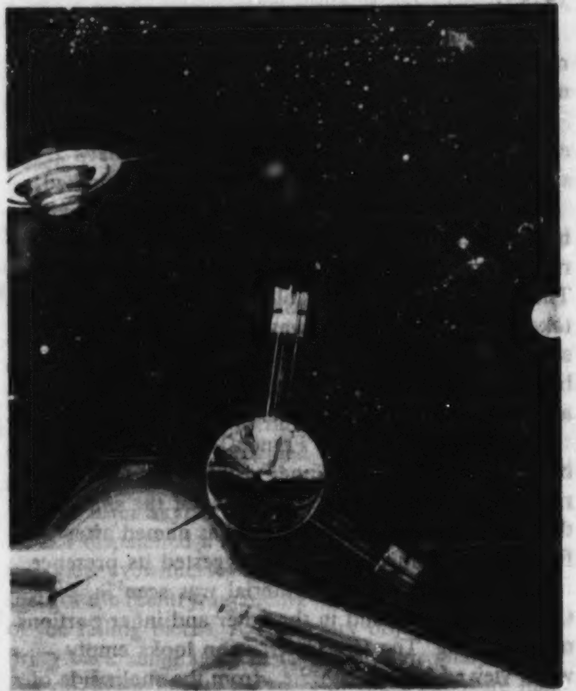
The Halley/Tempel 2 comet mission would be launched by a Space Shuttle in July 1985, with the spacecraft propelled in deep space by ion (solar electric) propulsion, a new fuel-efficient technology system now under development by NASA.

If approved, the Jet Propulsion Laboratory, will manage the mission for NASA's Office of Space Science. JPL also will be responsible for a rendezvous spacecraft system and mission operation. A European Space Agency project team will be responsible for the Halley probe. The design, development and implementation of the mission will involve the direct interaction of NASA and the European project teams and a Project Science Group composed of principal investigators, team leaders and selected interdisciplinary scientists.

Pioneer Saturn Results Summarized

NASA's Pioneer 11 spacecraft continues to work well after successfully flying past Saturn, the most distant planet yet reached in U.S. exploration of the solar system.

The space probe is now heading out of the solar system after returning the first closeup pictures of



Beginning of Pioneer 11's Odyssey—An artist's conception of the start of Pioneer 11 toward its five-year journey to ringed Saturn after flying past the planet Jupiter in December 1974. The Pioneer space probe is now leaving the solar system after obtaining pictures of Saturn and surviving the flight under its visible rings.

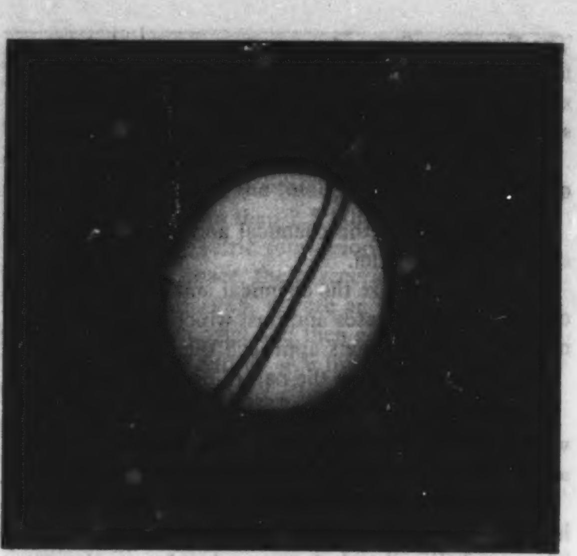
Saturn and making a number of important scientific findings, including the discovery of two new outer rings and possibly a new Saturnian moon. In addition Pioneer sustained no damage from high-velocity ring particles showing that spacecraft can operate safely in the vicinity of the visible rings.

After a six-year trip of more than 3.2 billion kilometers in space, Pioneer spent 10 days photographing and measuring the ringed planet. As it made its closest approach, Sept. 1, to within 20,800 km of Saturn's cloud tops at a speed of 114,500 km/hr some 1.6 billion km from Earth, Saturn's gravity swung it almost 90 degrees on a change of course toward the edge of the solar system.

Without a failure, Pioneer can return useful data until the late 1980's, when it reaches the limit of its radio contact with Earth.

Major findings about Saturn are:

- Saturn has an 11th moon. It was discovered in a photo taken of the outer edge of Saturn's rings and by instrumentation on board the spacecraft. Its estimated diameter is 400 km. It has been named 1979S1.
- Saturn has a magnetic field, magnetosphere and radiation belts. It joins Earth and Jupiter as a magnetic planet.
- Because of the low temperature measurements, evidence for the possibility of life on the planet's satellite Titan was discouraging, but not eliminated.
- Two new rings have been identified. One, which has been called the F ring, is separated from the A ring by a 3,600 km gap, called the Pioneer division. The F ring was clearly visible in a closeup picture taken some 943,000 km away from the planet. A second ring, the G ring, also was discovered and lies between the orbits of the satellites Rhea and Titan or about 500,000 km from the cloud tops.
- A feature called the French Division, a division between the middle and inner visible rings (B and C rings), was seen in Pioneer pictures of the shadow of the rings on Saturn's surface. It was named after French astronomers who first suggested its presence.
- Substantial particle material was seen in Cassini's Division and in the outer and inner portions of the A ring. The Cassini Division looks empty when viewed from Earth, i.e., from the sunlit side of the rings.
- The B ring was found to be so opaque that it allowed almost no light to pass through it.
- The C ring was found to have few particles and appeared as diffuse as Cassini's Division.



Saturnian Portrait—Scientists say this is the best view yet available of Saturn with its rings, returned by the Pioneer spacecraft during its encounter in August. The picture was taken 58 hours before closest approach and has undergone extensive computer processing to bring out detail.

- Pioneer found no evidence of either an innermost D ring or the expected outer E ring.
- Preliminary measurements of the ring mass indicate they have a low density. This suggests they are made up largely of ice.
- A substantial glow of atomic hydrogen was found around the rings which suggests absorption of protons from the radiation belts caused dissociation of water ice in the rings.
- Pioneer sustained two meteoroid hits above the rings and three more hits below the rings.
- Gravity field measurements indicate that Saturn is flattened about 10 percent at the poles by its rapid rotation and is not an oval body. It has a depression at midlatitudes of about 120 km.
- Gravity field analysis and temperature profile measurements suggest that the planet's core, extending out about 13,800 km from the center, is about twice the size of the Earth, but is so compressed by Saturn's huge mass that it contains about 11 Earth masses of material, largely iron and rock.
- Above the core, out about another 21,000 km the measurements suggest that the planet consists of liquid metallic hydrogen, which does not exist on Earth. The presence of liquid metallic hydrogen is supported by the discovery that the planet has a magnetic field. To produce this field, a planet needs fast rotation and a liquid electrical conductor in its interior—in Saturn's case, liquid metallic hydrogen.

- Two and half times more heat is radiated into space by Saturn than is absorbed from the Sun. One interpretation of this observation is that perhaps only a third of Saturn's heat is generated by leftover heat of planet formation and by continuing gravitational contraction, with most heat being generated by denser helium sinking through the planet's liquid hydrogen interior. The upper atmosphere was determined to be 5 C (41 F.) warmer than expected.

- Saturn's magnetic field is 1,000 times stronger than Earth's and 20 times weaker than Jupiter's. The field is unique because its north-south axis lines up with Saturn's rotation axis, unlike the 10 degree tilt to the rotation axis of Earth, Jupiter and the Sun.

- Saturn has a magnetosphere, a magnetic "bubble" in the solar wind which surrounds Saturn, which is larger than Earth's, but smaller than Jupiter's. The nose of the teardrop-shaped magnetic envelope is usually about 1,250,000 km from the planet. Its width is about 3,400,000 km.

- The planet has radiation belts made up of high energy electrons and protons which are comparable in intensity to those of the Earth, although the region they occupy is about 10 times larger. They are several hundred times weaker than Jupiter's.

- The radiation belts are completely eliminated by Saturn's rings because their high energy particles mirror back and forth between Saturn's poles about once a second, finally striking ring material which absorbs them. This is the most radiation-free sector of space yet found in the solar system.

- The moons Janus, Enceladus and Tethys also absorb large numbers of radiation belt particles.

- Closeup pictures showed Saturn's cloud tops, unlike Jupiter's. have few details.

- Saturn's cloud tops appear to be lower at the poles than at the equator. As a result polar clouds were seen ranging from dark blue to slightly green and changing to brownish belts around 55 degrees latitude.

- There appear to be jet streams around 70 degrees latitude and overall the planet appears to have more and narrower belts and zones than Jupiter.

- Infrared instrumentation showed the equatorial zone cooler than adjoining higher latitude regions and clouds of this zone are, therefore, probably higher. This suggests height and temperature differences between the belts and zones as expected.

- Ultraviolet instrumentation may have detected a generalized hydrogen glow or the presence of auroras on Saturn.

- Titan was found to have a cloud top temperature of −198 C (−324 F.). This very cold temperature eliminates an internal heat source as a means of warming Titan's surface, but leaves the possibility of atmospheric heating from a greenhouse effect.

- Light from Titan was found to be strongly polarized which is expected to allow determination of the kinds of aerosols or particles believed to be in the satellite's atmosphere.

- The ultraviolet instrument found a hydrogen cloud around Titan. This suggests its methane atmosphere is slowly breaking down into hydrogen and carbon, with the hydrogen escaping into space and carbon-based aerosols falling to the surface.

- Pioneer measurements are providing an improved mass and diameter for Titan. These measurements are expected to provide a density determination and estimates of its interior. Its density is believed to be low enough for it to contain significant quantities of interior ice.

- Titan has a magnetic wake within Saturn's magnetosphere. It extends ahead of the satellite instead of behind it, because of the planet's fast magnetosphere rotation.

The Pioneer program is directed by the Office of Space Science, NASA Headquarters. Project management is the responsibility of Ames Research Center. The spacecraft was built by TRW Systems, Redondo Beach, Cal.

Skylab Debris Finders Recognized

The National Aeronautics and Space Administration has prepared personalized plaques for 20 Australian citizens who provided the agency with debris they had gathered from the Skylab space station, which returned to Earth over the Indian Ocean and Western Australia July 11. A fragment of the Skylab material provided by the individual is attached to each plaque.

Soon after Skylab fell, without damage or injury, NASA dispatched a small group to Australia to interview eyewitnesses and otherwise determine the facts of the reentry, including the pattern of dispersion of the falling pieces. A secondary objective was to bring back small samples for laboratory analysis to determine the effects six years of space exposure had had on certain materials. Citizens who voluntarily surrendered pieces of the debris were assured they would be returned.

The plaques express the appreciation of NASA for the assistance rendered by the finders. They are

Skylab Souvenirs Sent Back—Dr. W. R. Lucas (R), director of Marshall Space Flight Center, and James E. Kingsbury, Science and Engineering director, examine the plaques mailed to Australian finders of Skylab debris. Attached to each plaque is a fragment of Skylab material, loaned to the Marshall center for study, and an expression of thanks by the space agency for assistance rendered by individual Australians.

signed by Dr. William R. Lucas, director of Marshall Space Flight Center, where the material was analyzed and the plaques were made.

Of the 22 specimens brought to Marshall by the center employees who returned from Australia in late July, 20 were determined to be from the Skylab. Analysis of the debris showed that all materials performed well, attesting to the soundness of the space station design. In some cases they performed well beyond expectations.

Laboratory study also indicated that Skylab did not experience reentry heating quite as high as had been predicted. The space station's reentry disintegration began at an altitude about 19 kilometers lower than had been expected, resulting in a "footprint" or area of debris distribution much smaller than anticipated; about 74 km wide and 4,400 km long, compared to the expected 185 by 7,400 km.

Residents of thinly-populated Western Australia continue to find and report pieces of the spacecraft. In late October, the State Emergency Services Group at Esperance sent photographs and descriptions of five small pieces that had been found. Earlier, a Perth writer who was on a Skylab "safari" found a large piece of aluminum weighing 80 kilograms near Balladonia. It has been determined that the aluminum most likely is a door from the film vault in the Skylab workshop.

Another significant "find" after the American group left Australia was a pair of titanium spheres which held nitrogen. They were near Rawlinna, in the area where two large oxygen tanks were found earlier. Although no hardware finds have been reported farther north (downrange) than Rawlinna, NASA authorities reason that several pieces have yet to be discovered within a few hundred kilometers of Rawlinna, the footprint ending at 26 degrees south and 131 degrees east, about 926 km northeast of Rawlinna.

Heavier Skylab elements not yet found include the orbital workshop film vault, and portions of the solar observatory, including the structure. control moment gyros and Experiment S054.

Pilot-Aid System for Small Airports

Flight demonstrations are being conducted by NASA of an experimental Automated Pilot Advisory System which broadcasts airport and air traffic advisory messages, using a computer-generated voice technique. The system automatically tracks aircraft within three miles of an uncontrolled airport and issues messages on air traffic location and heading. Uncontrolled airports are small, general aviation airports. Airport wind, barometric pressure, temperature and active-runway messages also are broadcast by the system.

Major objectives of the automated system are to:

- Broadcast airport advisory information at least once every two minutes.
- Broadcast air traffic advisory information at least once every 20 seconds.
- Broadcast collision warnings when required.

The technology being demonstrated at Wallops Flight Center has application to high-density uncontrolled airports where more than half of midair collisions occur. Accident factors include failure to see other aircraft and take evasive action, traffic pattern flow errors and the lack of communications. The technology also could find application as a possible shift-reliever at controlled airports (large air terminals).

Principal elements of the experimental system are a radar set, a mini- and a micro-computer, weather sensors and a very high frequency transmitter. The computers provide radar detection and target tracking, evaluation of weather sensor data and generation of the several audio voice messages for transmission to arriving or departing aircraft.

The program will attempt to optimize these techniques and to determine the feasibility of a low-cost radar and computer to achieve an automatic system tailored for the high-density, uncontrolled airport environment. NASA and the Federal Aviation Administration have established a cooperative program to insure compatibility of the system with an Automated Terminal Service project underway at the aviation agency. NASA is assisting in specifying the technical requirements and relative benefits of both the advisory system and the terminal service project.

The Wallops project manager is John L. Parks, Jr. Project coordinator is Gene Godwin and Loyd C. Parker is the principal investigator.

Apollo Facility Benefits Florida

A Kennedy Space Center hyperbaric chamber originally designed for emergency treatment of Project Apollo astronauts involved in high altitude spacecraft testing has embarked upon a new career in research, medical education and patient treatment at the University of Florida's Shands Teaching Hospital in Gainesville.

A hyperbaric chamber is a specially equipped pressure vessel that can be used to administer air or oxygen at greater than atmospheric pressure. The chamber was originally obtained for treatment of Apollo astronauts if decompression sickness—"the bends"—should occur during their training in altitude tests of the Apollo spacecraft.

No immediate requirement for the chamber existed at KSC after the conclusion of the Apollo program and Dr. Paul Buchanan, director of KSC's Biomedical Office, was instrumental in arranging its long-term loan to the Shands Teaching Hospital. The NASA/KSC unit has become the focal point of the hospital's Jerome Johns Hyperbaric Facility, named for the Starke, Florida, businessman who was instrumental in the chamber's transfer.

Skin diving is a popular recreation in Florida and "bends" cases resulting from divers surfacing too rapidly are not uncommon. The KSC chamber now in Gainesville is one of only four in the state able to treat with a pressure equivalent of 165 feet underwater (the others are located in Miami, Panama City and West Palm Beach). In addition, the chamber can treat three patients at once and is one of only a handful in the country which can be operated as a self-contained intensive care unit.

KSC Hyperbaric Chamber Dedicated—From left are Dr. William B. Deal, vice president for health affairs, University of Florida; Jerome Johns, after whom the facility was named; Dr. Jerome Modell, professor at the University of Florida College of Medicine, and Dr. Paul Buchanan of Kennedy Space Center's Biomedical Office.

A special building to house the chamber was built at a cost of $115,000 in state funds and skindiving groups contributed nearly $15,000 to the facility. The chamber was moved into its new building in January, 1979. After final construction adjustments and training of personnel in use of the chamber, the first patient was treated in July, 1979.

Eight patients received treatment between July and the facility's dedication in early November and hospital officials foresee up to 200 chamber runs per year in the near future. Diseases or conditions in addition to the "bends" responding to hyperbaric treatment include certain types of strokes, gas gangrene, severe blood loss anemia, carbon monoxide and cyanide poisoning, chronic bone infection, burns, and spinal cord trauma. Hyperbaric treatment has also been shown to be helpful in improving the survival of compromised skin grafts.

For a number of years, Shands had used a single-person hyperbaric chamber about the size of an iron lung. Once the patient was sealed inside the chamber, medical personnel had no means of providing treatment or other care. In the new chamber, there is room for one or more attendants and a physician can be "locked" in and out if necessary.

"We had no immediate mission at KSC for the chamber and lacked the funds and facilities to operate it," commented Dr. Buchanan. "This example of state and federal government cooperation has established a valuable treatment and research facility. I guess it would be fair to regard it as another very useful public benefit from Project Apollo."

Fuel Cell Promises Energy System

Development of a fuel cell-powered energy system that will not only generate electricity for buildings but use waste heat from the process for room heating is being managed by NASA's Lewis Research Center, for the Department of Energy's Phosphoric Acid Fuel Cell Systems Program. The project is part of the Department of Energy's effort to develop technologies permitting a transition from petroleum and natural gas to alternate, synthetic fuel sources.

In operation, the fuel cell electrochemically combines hydrogen and oxygen to produce electricity. A fuel conditioning system produces hydrogen from fuels such as natural gas or naphtha. Oxygen is supplied from the air. In the future, hydrogen could be obtained from synthetic liquid or gaseous fuels.

Fuel cell configurations and fuel processors will be developed in the NASA Lewis project and designs established for a 30-kilowatt fuel cell and 60-kilowatt fuel conditioner. The overall system will be so efficient that the amount of fuel normally required to heat a home or apartment would also provide 40 percent of the electrical needs.

Follow-on work is expected to lead to a 120-kilowatt integrated energy system that will meet all the heating, cooling and electrical needs of an apartment complex or a small shopping center with much higher efficiency than is possible with conventional systems.

Westinghouse Electric Corp. Research and Development Division, Pittsburgh, as the prime contractor, is responsible for overall system integration and analysis, the fuel conditioner and the heat recovery subsystems. Energy Research Corp., Danbury, Conn., the major subcontractor, has responsibility for the fuel cell development. Work will be performed at the contractors' plants in Pittsburgh and Danbury.

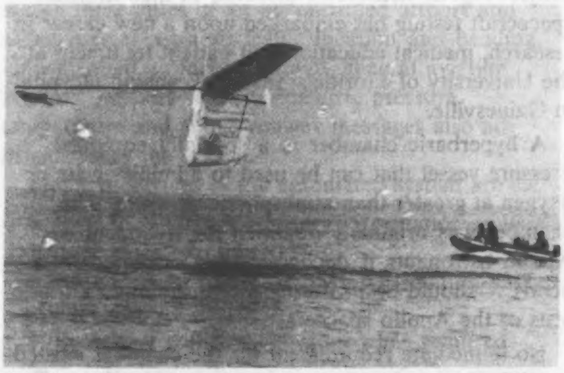
The two-year $4,400,000 Westinghouse contract, calling for design, test and analysis of key components of the system, will lead to installation in the mid-1980s of experimental systems at several sites in the United States.

Gossamer Albatross to Fly For NASA

A short-term flight research program with one of the world's most unusual aircraft, the human-powered Gossamer Albatross will be funded jointly by Dryden Flight Research Center and the NASA Langley Research Center. They will study the flight characteristics of a light-weight, low-speed aircraft for possible application to future aircraft capable of flight at extreme altitudes.

The Gossamer Albatross No. 2 is one of several human-powered aircraft designed and built by Dr. Paul MacCready, president, AeroVironment Inc., Pasadena, Cal. The vehicle to be flown in the NASA program is the sister ship of the Gossamer Albatross No. 1 which made history by flying across the English Channel under human power last summer. The Gassamer aircraft are powered by the pilot who pedals a bicycle-like arrangement that drives the propeller.

Special emphasis of the study will be on utilizing a lightweight data system to measure aircraft stability, control and performance characteristics. The aircraft will be flown at Dryden using human power, towed (propeller-off) flight and later, an electric motor for steady-state conditions. The flight program will be conducted primarily by AeroVironment under a $65,000 NASA contract.



NASA to Study Pedal Power—Gossamer Albatross I is the strange contraption that flew the English Channel in the summer of 1979, its only power provided by the pilot who pedals a bicycle-like unit that drives the propellor. A sister ship will undergo tests at both the Langley and Dryden centers.

New Device Detects Cancer

An instrument that makes use of space technology is being evaluated as a detector of cancerous tumors in the human body. Developed at Langley Research Center, the device—called a microwave applicator—is being tested at the Eastern Virginia Medical School at Norfolk General Hospital, and also will be tested for use in the treatment of cancerous tissue by heating a tumor to destroy cancer cells. The device has demonstrated already that it can locate tumors in

14 known cancer patients and has even found a cancerous site in one patient that was undiscovered by conventional techniques.

The microwave applicator's prime advantages are that it does not emit radiation, is used outside the body and should become relatively inexpensive if mass-produced.

If the instrument proves itself after an extensive series of hospital and laboratory experiments it could become standard equipment in doctors' offices. Patients could be quickly and easily tested for many forms of cancer, just as they are tested routinely now for heart problems with an electrocardiogram machine.

The microwave instrument contains a sensitive radiometer that can measure temperature variations of less than 0.1 degree Celsius (0.2 degree Fahrenheit). Because cancerous tissues are hotter than surrounding normal tissue, they are thus detectable by the applicator. The applicator also can detect heat differences much deeper in the body than conventional infrared thermography, where techniques are limited to detecting tumors near the skin's surface.

The next step in proving the instrument will begin early in 1980 when researchers at the Norfolk Medical School and at the Medical College of Virginia in Richmond test the device's ability to treat cancer in large laboratory animals. The treatment method will involve microwave heating of a tumor area to destroy cancer cells. Temperatures higher than 42 C (107.6 F.) are considered lethal to cancerous tissue.

Tumors have a poorer vascular system (fewer blood vessels) as compared to healthy tissue and contain more fluid. Researchers believe that heat from the microwave system will heat a tumor faster than the surrounding tissue because of the higher moisture content and the tumor will stay hotter because there are fewer blood vessels to carry the heat away.

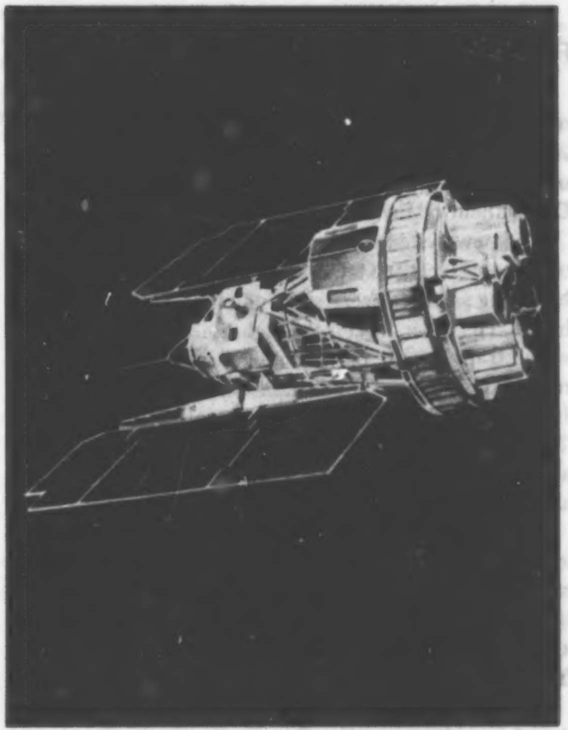
The project began when a Langley researcher suggested that microwave experts, who normally work on satellite communications and other space projects, should get involved in some way with using microwave techniques to detect and treat cancer. After preliminary research and development, Microwave Associates, Inc., of Burlington, Mass., which has worked with NASA for several years on aerospace projects, was asked to develop and build the instrument. Total funding to date, from the NASA Technology Utilization Program, has amounted to less than $47,000.

Landsat 2 Shows its Age

Landsat 2, the nation's second in a series of Earth orbiting satellites used to monitor the world's resources, shows signs of wearing out after almost five years of continuous service. The spacecraft, with a designed life expectancy of only one year, has been experiencing difficulty in its onboard attitude control mechanism.

Controllers at the Goddard Space Flight Center, believe that a rotating flywheel used to stabilize the spacecraft's yaw, or side-to-side motion, has become jammed due to degraded lubrication. The controllers have succeeded, since the problem was discovered on Nov. 5, in reorienting the spacecraft's solar panels toward the Sun. Now, power supplies are adequate for operations and the attitude can be maintained, thus allowing more time to free the jammed yaw control flywheel or attempt an alternate control procedure.

If Landsat 2 joins Landsat 1 (launched in 1972 and shut down in 1977) in retirement, Landsat 3 will remain as the sole Earth resources monitoring satellite in orbit until Landsat 4, the fourth and most advanced spacecraft in the series, is launched in late 1981.



Artist's conception of Landsat 2 orbiting.

There was hope that Landsat 2, despite its age, could provide supplemental worldwide coverage to Landsat 3 until late 1980. Landsat satellites weigh about 900 kilograms and orbit the Earth every 103 minutes, some 910 kilometers in space. Their remote sensing instruments send back images of Earth in 185-km strips running nearly north-to-south at an angle to the equator of 99 degrees. In this type of orbit, surface coverage of the Earth proceeds westward, with a slight overlap, so that the globe is covered every 18 days.

Landsat data has been used by scientists and local officials in the United States and more than 100 foreign countries for a wide variety of applications ranging from crop inventories to flood assessment and mineral exploration.

In addition to the three Landsat monitoring stations in the United States, seven foreign Landsat ground stations operate throughout the world with several more under construction and a number of others in the planning stages.

It is expected that these domestic and foreign ground stations will have the capability to receive, process, archive and disseminate Landsat 3 data on a global scale to partly offset the effect of the loss of Landsat 2.

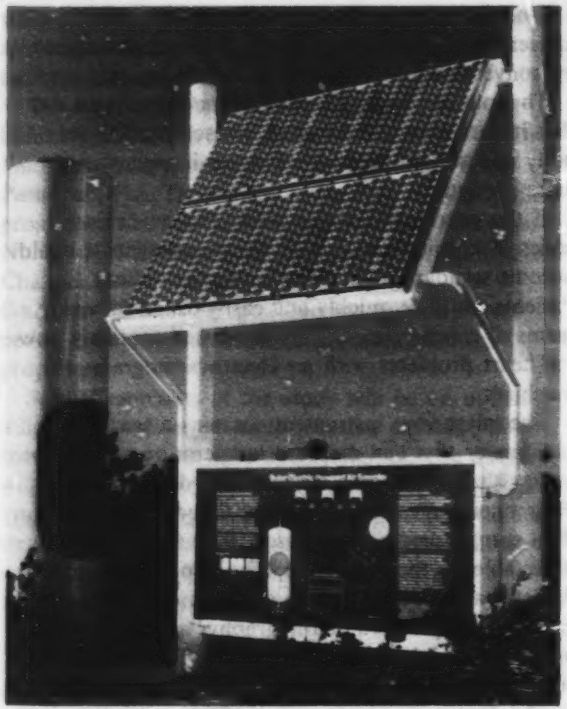
First Solar Electric Air Sampler Unveiled

The nation's first solar photovoltaic-powered air monitoring station was dedicated Nov. 20 by New Jersey Governor Brendan Byrne and representatives of the U.S. Department of Energy, the New Jersey Department of Environmental Protection and NASA.

The new system is designed to determine whether or not air meets the state and federal health standards by taking samples every sixth day for a period of 24 hours. The air is forced through a glass fiber filter which traps minute particulate matter. Filters are then removed each week for examination by the New Jersey Bureau of Air Pollution Control in Trenton. The new unit, in Liberty State Park, N.J., is the latest addition to a statewide network of more than 100 air sampling stations.

The heart of the new silently operating, non-polluting, 360-watt solar power station is its 8.9-square-meter array, consisting of 20 photovoltaic modules, a total of 860 individual silicon solar cells. The entire array is mounted on a 5.2-m tubular aluminum frame.

During the day, the station is totally powered by the photovoltaic system. Excess electrical energy produced by the system is stored in a bank of lead-acid batteries, specifically designed for solar electric use. Power is withdrawn from the batteries to run the station during the evening and early morning hours of its weekly 24-hour cycle.



Solar air sampler now in operation.

Total cost of the project, funded jointly by the two state and federal departments, including the air monitoring equipment, the photovoltaic power unit, the display, design and installation, is $93,000.

The purpose of the Department of Energy photovoltaic program is to develop solar cell power systems which can provide a significant amount of the nation's electrical energy requirements by the year 2000. The project at Liberty State Park is one of several sponsored to stimulate early markets for solar photovoltaic power through cooperative cost-shared experiments with potential users. Additionally, this project displays to the general public the practical value of solar electric technology.

Solar photovoltaic systems have shown important economic gains in the past few years. The cost of solar-generated electricity was about $7 per kilowatt-hour (1980 dollars) in 1976; today, costs range from $1 to $2 per kilowatt-hour. The Department of Energy hopes to see that price drop to under 10 cents per kilowatt-hour in the late 1980s, at which time electricity generated by the Sun will become competitive in many areas with more traditional power sources.

The solar power air monitoring system was produced under management of the NASA Lewis Research Center as part of the Department of Energy's National Photovoltaic Convention Program. More than 20 solar photovoltaic power systems designed by NASA Lewis are in operation in the United States and overseas providing electricity for diverse applications such as isolated villages, forest lookout towers and weather stations. In remote areas of the world, photovoltaic systems already are competitive in cost with alternative power sources, such as diesel generators.

Donald Beattie, Director of NASA's Energy Systems Division, commented: "This is just one of the many cooperative efforts with the Department of Energy and NASA is proud to have the opportunity to work with industry, state and local officials to bring this viable renewable energy source into a 'real world' application."

Weather Eye from Space

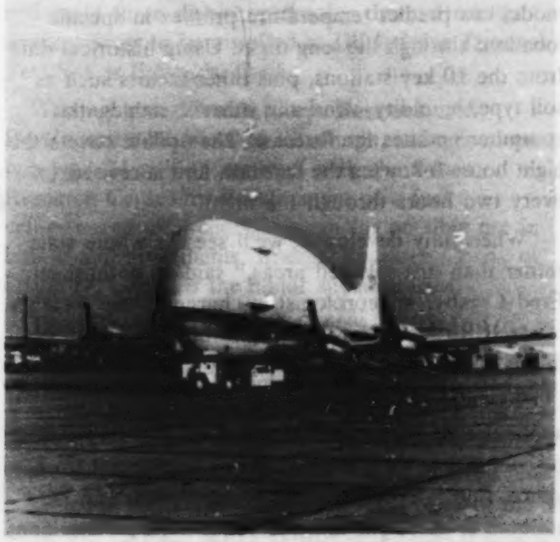
Forecasting a cold snap, how cold it will be and for how long, and when and where it will occur is vital to Florida's multi-billion dollar agricultural industry. Failure to turn on wind machines, fire up citrus grove heaters or take other measures can mean the loss of an entire crop. On the other hand, the costs of standing by to perform these functions runs up to $43,000 per hour for the citrus industry alone, and the expense of using all protective means can hit $6 million for each night of operation. Guessing either way isn't good enough.

The growers need the answers. For the past several years, they have come from space, and the system is being improved. Entering the payoff stage is a project by the National Weather Service, the University of Florida and Kennedy Space Center to develop a computerized forecast ability for freeze conditions.

The eyes of the system is the National Oceanic and Atmospheric Administration's (NOAA) weather satellite with a formal name of Geostationary Orbiting Environmental Satellite 1, which is in a stationary orbit 35,000 kilometers over the equator in a position above Colombia, South America.

The satellite provides forecasters with both regular photographs and infrared pictures every 30 minutes. Two aspects of the photos allow the weathermen to

Taking the Guppy—Rotor System Research Aircraft (RSRA) Number One disappears into the maw of the NASA Super Guppy after flight tests at the Wallops center and the giant transport plane readies for the trip back to Ames Research Center. RSRA Number One flew at Wallops in the winged compund configuration. Aircraft Two, which flew at Wallops in a pure helicoptor configuration, left for Ames aboard the Super Guppy earlier this year. The two research aircraft, nicknamed "Heathcliff" and "Gertrude" respectively by their Sikorsky manufacturer, are heavily instrumented and can accommodate a variety of different rotor systems for testing as a hybrid copter-airplane.



predict night-time freezes in Florida. First, the infrared pictures from the satellite reveal heat levels instead of visible features. Second, freezing conditions rarely occur during cloudy conditions in Florida, so the satellite sees ground or treetop temperatures rather than those of cloud tops on most nights. The readings of temperatures from the satellite are accurate to within two degrees Fahrenheit and each tiny element or "pixel," of the transmitted picture covers an area about 8 km on a side.

The satellite beams its information to a receiving station at the National Environmental Satellite Service in Suitland, Md. It is then fed in a digital format to computer complexes in field stations throughout the country.

The station of interest to Florida agriculture is NOAA's National Weather Service installation at Ruskin. NASA's contribution to the system, besides that of originally launching the satellite, is a highly sophisticated computer and image analyzer which transforms the digital data from electrical signals to a multi-color display of temperature profiles.

Each color in the television map represents a specific temperature range, giving forecasters an accurate picture of the advancing cold air. The satellite data, plus reports from field locations, allow forecasters to present a much more accurate and detailed summary of what is occurring across the state. To predict what will continue to occur, over as much as eight hours, the computer uses a University of Florida developed program or "mathematical model" to predict temperature profiles in specific locations through the long night. Using historical data from the 10 key stations, plus other factors such as soil type, humidity, wind and other variables, the computer updates the forecast. The update covers the eight hours following the forecast, and is revised every two hours through the night.

"When fully developed, we'll see the whole state rather than just selected areas," said an enthusiastic Fred Crosby, meteorologist-in-charge of the weather office at Ruskin. "This is going to be a powerful tool for us."

Crop planning is another possible use for the sophisticated system. Areas which tend to stay warm or cool due to local influences can be mapped from space. Future crop plantings in these areas can be tailored to those plants which require the predominant temperature profiles of the area.

In Strictest Confidence—Dr. Jeanne Richmond, who recently began work as a part time counseling psychologist at the Marshall center, exercises extreme care in her dealings with employees. The secretary who answers her telephone does not ask the caller's name; Dr. Richmond does not leave her name on a return call and doesn't even keep notes for her own records. "For obvious reasons, we feel this confidentiality is necessary", Dr. Richmond says, "I am the only person at the Marshall center who knows my clients or what problems they have." She has been in counseling and psychology for more than 20 years and holds four degrees from three universities.

TMI Commission Honors Ten from NASA

The President's Commission on the Accident at Three Mile Island was created by President Carter's Executive Order 12130 on April 11, 1979, and was charged with conducting a comprehensive study and investigation of the accident involving the nuclear facility and making recommendations based on its findings. Dr. John Kemeny, president of Dartmouth College was appointed chairman of the twelve member commission. On October 30, 1979 the commission presented their report to the President. The report, along with 10 volumes of legal and technical staff reports, represent the finding of more than two hundred experts, consultants and government employees engaged in the investigation.

On November 15, Dr. Kemeny conducted an

awards ceremony to honor the participants. The following NASA employees received Presidential Commission Awards:

Vincent L. Johnson-NASA Headquarters—Distinguished Service Award; Leonard Jaffe-Headquarters—Exceptional Service Award; William M. Bland, Jr.-Johnson Space Flight Center—Exceptional Service Award; Robert English-Lewis Research Center—Certificate of Appreciation; A. Virginia Barnes-Headquarters—Certificate of Appreciation; Dwight Reilly-Lewis Research Center—Sustained Superior Performance Award; Francis T. Hoban-Headquarters—Exceptional Service Award; Fred Bowen-Langley Research Center-Exceptional Service Award; Richard Sprince-Headquarters—Certificate of Appreciation. Mary Woolard-Headquarters—Letter of Appreciation. The President's Commission was terminated in December.

JSC Executive Honored in Washington—Dr. James E. O'Neill, left, Acting Archivist of the United States, presents the Award for Excellence of the Association of Records Managers and Administrators to Robert R. Regelbrugge, chief of the Institutional Support Development Branch, Johnson Space Center; Col. Lawrence W. Vogel, NASA Headquarters Administration Director looks on. Regelbrugge was honored for his development of the Interactive Basic Accounting System, now a fixture at JSC.

Contractor News

Rocketdyne Division of Rockwell International Corp., of Canoga Park, Calif., has finalized with NASA the issuance of a $365.7 million amendment to an original 1972 contract to build Space Shuttle main engines. The amendment authorizes Rocketdyne to proceed with the manufacture and testing of 12 additional main engines, as well as the overhaul of 10 engines and tests to 109 percent of rated power level. Marshall Space Flight Center is responsible for development of the Shuttle main engines and other major elements.

Honeywell Information Systems, Inc., Federal Systems Operations, of 7900 Westpark Ave., McLean, Va., has been awarded a contract modification by the Kennedy Space Center for continued maintenance and software support of the Space Shuttle Launch Processing System's data subsystem in KSC's launch control center. The new award brings the aggregate value of the parent contract to $56 million plus.

The Vought Corp., a subsidiary of LTV Corp., of Dallas, Tex., has received two contract modifications from NASA for Scout launch vehicles and support services. One modification calls for Vought to build five Scout vehicles and five payload heatshields. The work, to be performed in Dallas, is valued at just under $4.3 million. The second modification, valued at approximately $16 million, is a two-year extension of work involving systems management, reliability and quality assurance, vehicle processing and launch and logistics support services through 1981. The Scout, NASA's smallest launch vehicle, is managed by the Langley center.

General Electric Company's Space Division, of Valley Forge, Pa., has been awarded a 16-month $1.2 million contract by the Jet Propulsion Laboratory for DoE to design and build prototype units for solar energy to provide electrical power to small communities and rural areas. Under the contract, GE will build three dish-shaped solar thermal energy concentrators to be installed at JPL's Solar Thermal Test Site at Edwards, Calif.

Westinghouse Electric Corp. Research and Development Division, of Pittsburgh, has agreed on a two-year $4 million contract with the Lewis Research Center for development of a fuel cell-powered total energy system for possible use in homes and apartments. Energy Research Corp., of Danbury, Conn., is the major subcontractor.

The Hampton Technical Center, division of Kentron International, Inc., of Dallas, Tex., has been selected to provide technical support work for research and development programs at the Langley Research Center. The two-year agreement is a continuation of previous contracts with Kentron and is valued at approximately $24 million. Most of the work will be done at the Hampton Technical Center with certain special tasks performed at Langley.

Did You Know?

Idea Clearinghouse, now a going concern, was established in the fall to disseminate proven good ideas throughout the agency. One of the first ideas accepted was modernization of the drive unit on Monarch lathes, developed by the Ames Research Center. Ames personnel worked for six months to modernize "EE" Monarch lathes that were scheduled for replacement, at a significant savings to the center. Ideas and innovations should be cleared through the Headquarters Information Systems Division, NSM-12.

KSC Bus Tours, following a decline of four consecutive months, picked up in the last quarter of 1979. Tour patronage through May of last year had been proceeding at a record pace as the Kennedy center continued its buildup for the first manned orbital flight of the Space Shuttle, then dropped sharply with nationwide gasoline shortages. In October, guided bus tours of the Spaceport and the Cape Canaveral Air Force Station attracted 64,437 visitors, up 2.3 percent over the same month in 1978.

The Goddard Photographic Section has been named Department of the Year (Engineering Category) by the Professional Photographers Association and the Eastman Kodak Company for its design in providing on-the-spot records of maps and census data. The GSFC shop developed a method of rapidly and accurately photographing computer graphics drawn on video-display terminals.

The Navajo Division of Resources successfully demonstrated their automated resource inventory system to some 25 tribal officials in Tsaile, Arizona. In 1977, the Navajo Tribe began a joint project with NASA to utilize information from Landsat satellites on soils, topography, rainfall and vegetative cover. NSTL's Earth Resources Laboratory has worked with the Navajo for the past two years.

The National Secretaries Association announced the results of its grueling two-day certification examination and Gretchen Evans, graduate of GSFC's Certified Professional Secretary Training Program, was the only Maryland resident to pass the exam; another graduate of the Goddard program, Teresa Ricketts, was among the 10.6 percent nationwide who passed the initial testing. The training course for secretaries began with an incentive program established by the Goddard center in 1976.

The Relativity of Roundness—The new device is called an Ultra-High-Precision Roundness Measurement System and it can determine the sphericity (roundness) of an object to an accuracy of .005 of a micro-meter. Jack Reed (foreground) and Roy Taylor of the Marshall center are shown measuring a small quartz ball which turns out to have a diameter of exactly .038 meters. The system is used primarily to measure spericity of rotors for gyroscopes for Gravitational Probe B (GP-B) which may be launched from the Space Shuttle in the mid-1980s. In Earth orbit, the GP-B would measure the minute precession, or change of axis, which Einstein's theory of relativity says will occur in a spinning body, such as a planet or gyro, revolving about a large mass.

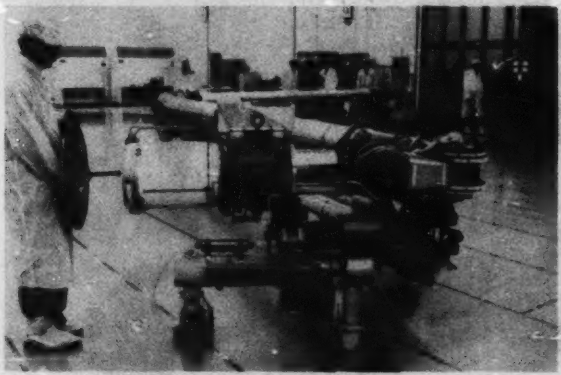
Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

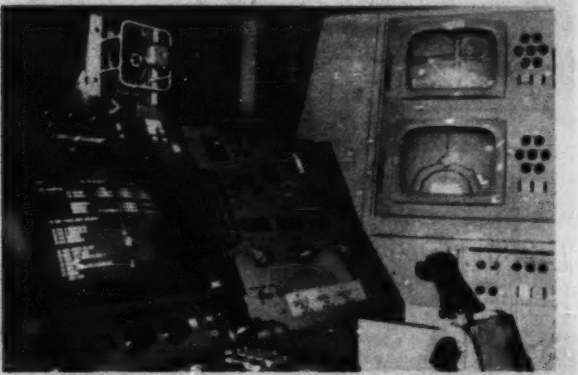
Inventor(s) and Employer	*Title*	*Patent No.*	*Installation*
Arthur A. Rudmann, GSFC	Coupling device for moving vehicles	4,173,324	GSFC
John G. Simpson, MSFC	An improved solar concentrator	4,173,397	MSFC
Robert L. Mueller Robert K. Yasui, Caltech/JPL Pasadena, Cal.	Solar array strip and a method for forming the same	4,173,820	NRO/JPL
Robert P. Gruber, LeRC	Self-reconfiguring solar cell system	4,175,249	LeRC
Eldon Jeffers Richard R. Thomas, Boeing Aerospace Company, Houston, Tex.	Method and apparatus for eliminating luminol interference material	4,176,007	MSC
William A. Leary, GSFC Charles R. Griffin	Antenna deployment mechanism	4,176,360	GSFC

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January	Atlas Centaur	ETR	DOD Navy. Reimbursable
SMM-A	January	Delta	ETR	NASA. Scientific Solar Maximum Mission.
Intelsat V-A	February	Atlas Centaur	ETR	Intelsat communications. Reimbursable.
NOAA-B	April	Atlas-F	WTR	NOAA Weather. Reimbursable.
Intelsat V-B	May	Atlas Centaur	ETR	Intelsat communications. Reimbursable.
Navy-20	July	Scout	WTR	DOD Transit. Reimbursable.
GOES-D	August	Delta	ETR	NOAA Weather. Reimbursable.
Intelsat V-C	August	Atlas Centaur	ETR	Intelsat communications. Reimbursable.
Navy-21	October	Scout	ETR	DOD Transit. Reimbursable.



Shuttle's Canadian Connection—The Remote Manipulator System, nearing completion in Toronto, will provide the Shuttle orbiter with its space "arm". Designed and built by Spar Aerospace, Limited, the assembly will have the dexterity to deploy or retrieve a variety of payloads in space flight.



Remote Manipulator's "Office"—Operator Complex is a replica of the control station for simulation purposes that will be the aft flight deck of the Shuttle orbiter. Simulated view of the cargo bay and payload (on TV monitor) is seen from the cargo bay aft bulkhead over a closed circuit (CCTV) television system.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Silent Partner in Cardiology

Education of medical students in cardiology requires access to patients having a variety of different forms of heart disease. But bringing together student, instructor and patient is a difficult and expensive process that does not benefit the patient. An alternate approach is substitution of a lifelike mannequin capable of simulating many conditions of heart disease. The mannequin pictured below, together with a related information display, is an advanced medical training system whose development benefited from NASA visual display technology and consultative input from NASA's Kennedy Space Center.

The mannequin system represents more than 10 years of development effort by Dr. Michael S. Gordon, professor of cardiology at the University of Miami (Florida) School of Medicine. Dr. Gordon was assisted by colleagues at the medical school, by the New York firm of Messmore & Damon which builds the mannequins, and by NASA's Biomedical Applications Team, Research Triangle Institute, North Carolina

The electronic mannequin simulates 40 heart disease conditions with a high degree of realism, for example, chest movement, pressure in artificial veins and arteries, and sounds of heartbeat rhythms. On the accompanying display unit, the instructor or student can push buttons to call up such information as patient histories, electrocardiograms, x-rays, blood circulation data and responses to medical and surgical treatments. The mannequin has proved a valuable educational aid at the University of Miami, Duke University Medical School, Yale University Medical School and the American College of Cardiology. The system is being produced commercially by Messmore & Damon.*

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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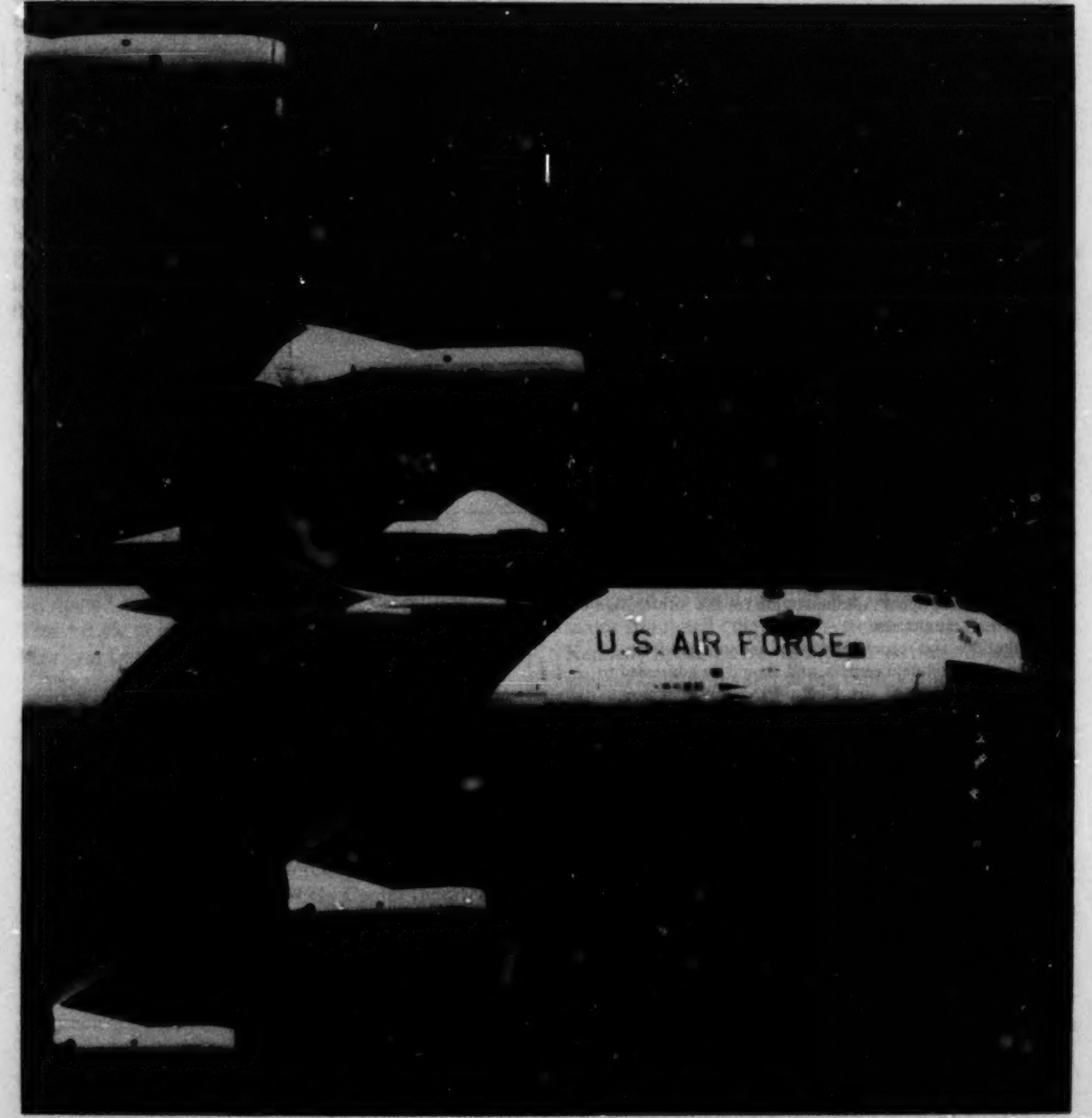

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Cover

Future Fighter and Mother Plane—The tiny, radio-controlled research craft called HiMAT (highly maneuverable aircraft technology) hangs beneath the wing of a B-52 over the Dryden Flight Research Center in California. Beginning last summer, the remotely piloted research vehicle has been flown and tested to investigate advanced technology that could lead to greater maneuverability in future military aircraft. With lessons learned from HiMAT, U.S. fighters of the 1980s and 1990s may substantially out perform today's most modern attack aircraft, able to sustain twice the turn rate of present-day fighter planes at transonic and supersonic speeds.

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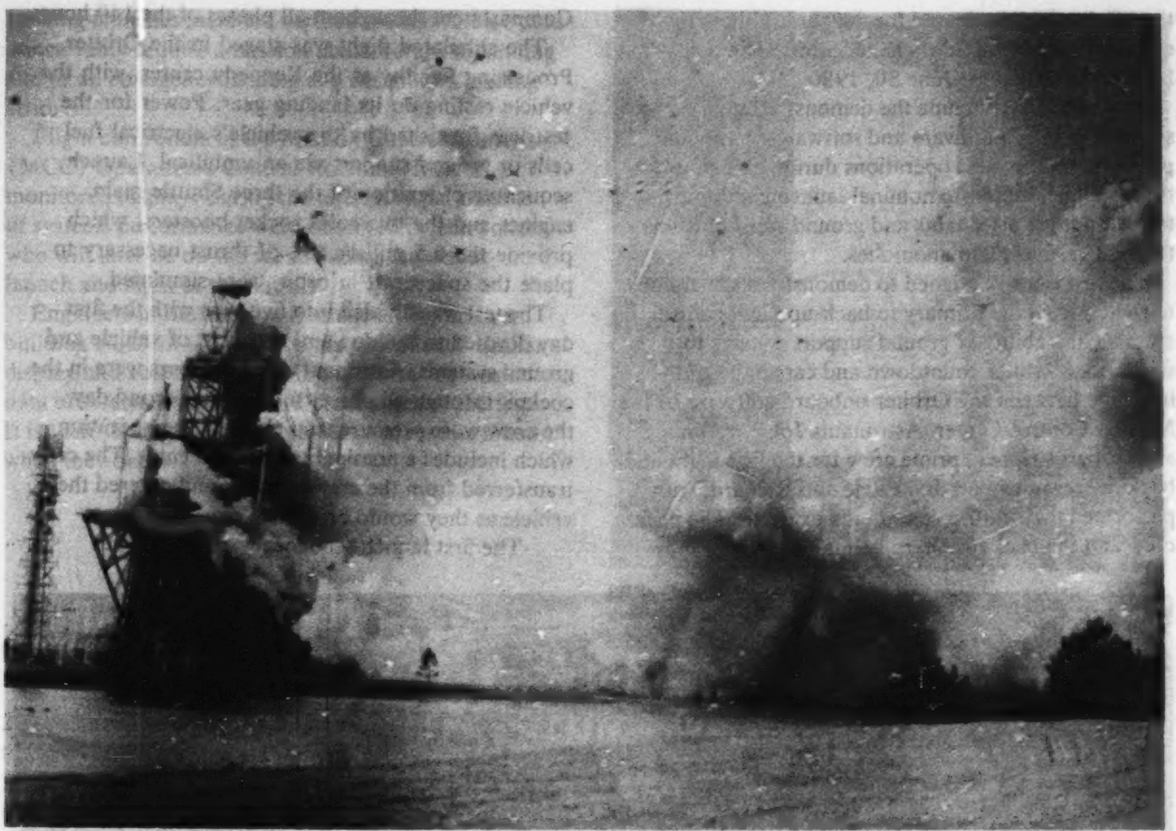


Storybook Success for Main Engine—After a disappointing performance in November blamed on a faulty welding wire, the Space Shuttle Main Propulsion Test Article scored an impressive runthrough in mid-December. NASA cameras at Bay St. Louis captured the blast from the 550-second test run.

Shuttle Test Engines Fired

A successful full-duration test of 550 seconds was conducted on the Space Shuttle Main Propulsion Test Article at NASA facilities at Bay St. Louis, Miss., on Dec. 17.

The three main engines were throttled from 100 percent rated power level to 90, 80 and finally, to 70 percent. Engine gimballing and pulsing were accomplished successfully.

One engine was cut off early, as planned, and the remaining two were run at 70 percent of rated power level for the last 5 seconds of testing.

No problems were encountered and test managers for NASA's Marshall Space Flight Center reported that all test goals were achieved. According to one NASA spokesman, the rockets roared back to life with "storybook" success.

Dress Rehearsal at the Cape

"Columbia", the first Space Shuttle Orbiter scheduled for flight in 1980, has undergone its first major simulated "flight" all systems test at the Kennedy Space Center in Florida. Astronauts and ground support teams put the vehicle through an around-the-clock critical operational runthrough following several days of delay and cancellations.

Among the tests performed during the 140-hour period were five separate launch and ascent flight profiles, on-orbit operations and one entry phase. Several hundred NASA and contractor aerospace engineers were on hand for the Orbiter Integrated Test, among them personnel from the Kennedy Launch Center, the Johnson Space Center, Houston, and Rockwell International Space Division, Downey, Calif.

The Orbiter Inegrated Test is one of the final verifications of Orbiter systems and electronics before the "Columbia" is cleared for final assembly with external tank and solid rocket boosters. The first launch is planned for June 30, 1980.

Test objectives include the demonstration of selected Orbiter hardware and software (computer programs) subsystem operations during a mission timeline. In addition to nominal launch conditions, the test put the astronauts and ground support teams through various flight anomolies.

The test is also designed to demonstrate the ability to switch from the primary to back-up flight control systems, the ability of ground support systems to support an Orbiter countdown and capability of the interface between the Orbiter onboard software to the Mission Control Center. Astronauts John W. Young and Robert Crippen, prime crew for the first flight and backup crew members Joe Engle and Richard Truly performed their future roles in the exercise. The prime crew and the backups alternated in the Orbiter crew Compartment throughout all phases of the 140 hours.

The simulated flight was staged in the Orbiter Processing Facility at the Kennedy center, with the vehicle resting on its landing gear. Power for the test was furnished by the vehicle's electrical fuel cells or ground support via an umbilical. Launch sequences of ignition of the three Shuttle main engines and the two solid rocket boosters, which provide the 6.5 million lbs. of thrust necessary to place the spacecraft in orbit, were simulated.

The test was divided into five runs with the first day devoted to buildup and checkout of vehicle and ground systems. Astronaut crew members were in the cockpit through all phases and on the second day the crew wore pressure suits through the operation which includes a nominal launch and entry. The crew transferred from the crew quarters and entered the vehicle as they would on launch day.

The first launch sequence was normal, but

Simulation for the Senior Astronaut—During December's successful simulated flight of the Space Shuttle Orbiter, John W. Young was at the controls as commander of the primary crew. Young, a retired Navy Captain, has been flying space missions since 1965. A veteran of the Gemini program, he flew on the first manned mission, Gemini 3, and commanded Gemini 10. Young circled the Moon with Apollo 10 and landed there as commander of Apollo 16. He is chief of the Astronaut office at the Johnson Space Center. The first actual Shuttle mission, and the era of space transportation, begins under his sure hand.

ensuing launches included various modes which would conceivably require a mission abort, return to landing site or an emergency landing at a designated landing strip.

Flight controllers at the Mission Control Center's (MCC) Operation's Control Room at Houston, monitored displays during the tests. Key parameters of systems performance were observed by controllers who will later be on the scene during the actual launch and flight of the Shuttle.

Engineers in the Mission Evaluation Room in a building adjacent to the MCC also monitored similar display and voice loops. Their concentration was on data of selective portions and procedures of the test. It is their job to develop solutions to problems if and when they occur.

Candidates For Astronaut

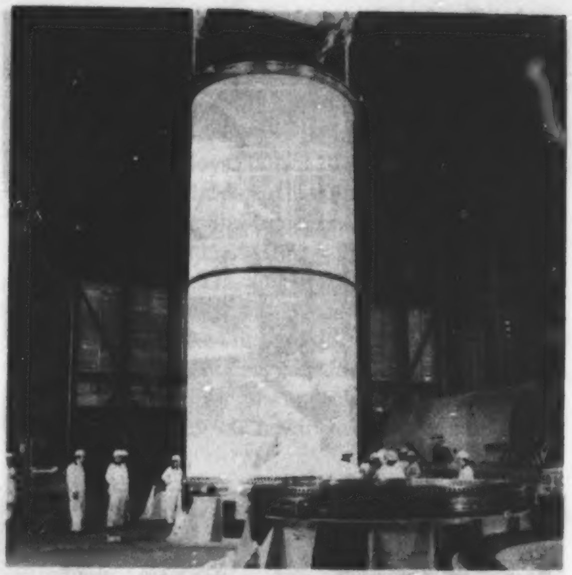
A total of 2,937 men and women applied for 10 to 20 open astronaut positions during a NASA two-month recruiting drive that ended Dec. 1. More than 300 of the hopefuls applied for both mission specialist and pilot categories. Future Space Shuttle missions will employ astronauts in both categories.

The number of women applicants for the two categories totals 390. The astronaut selection board at the NASA Johnson Space Center, Houston, will narrow the selection to those best qualified in the two categories. Approximately 100 will be selected for preliminary screening and physicals at the center next spring.

Those selected as astronaut candidates will report to Johnson in July 1980 for their one-year training and evaluation period. Final selection as an astronaut will depend on satisfactory completion of the evaluation period.

Pay for civilian candidates will be based on the federal government's General Schedule for grades GS-11 through GS-14, with approximate salaries from $20,611 to $34,714 per year. Military candidates will be assigned to Johnson but will remain on active military status for pay, benefits, leave and other military matters.

NASA plans to accept applications for Space Shuttle astronauts on an annual basis. The number of open positions will depend on NASA's need for pilots and mission specialists.



SRBs Coming Together—A forward center segment of the first Solid Rocket Booster destined to launch the Space Shuttle is off-loaded in the Kennedy center's Vehicle Assembly Building. Other SRB components, such as the aft skirt and aft motor segments, are already in place on the mobile launch platform. The positioning processes is called "stacking" and rollout of the complete Shuttle stack—orbiter, SRBs and external tank—is targeted for mid-April 1980.

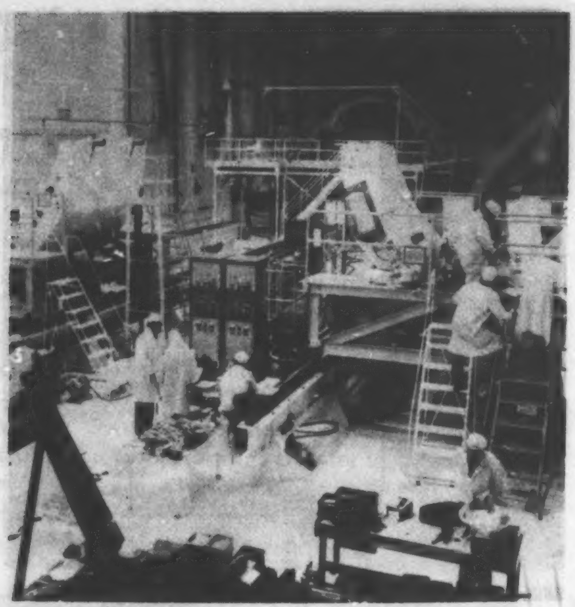
Life Science Investigations Chosen

NASA has selected 78 life science areas of investigation—74 proposals from the United States and four from three foreign nations—for two life science Spacelab/Space Shuttle flights planned between 1983 and 1985. Specific investigations will be selected for each mission about two years prior to flight.

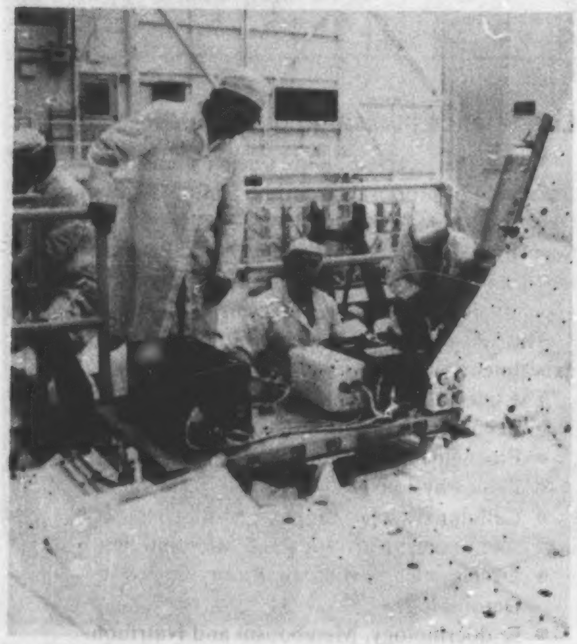
The 78 were chosen from about 370 proposed experiments.

The selected investigations include the following:

- Behavior and Performance
- Bioengineering/Technology
- Plant Physiology
- Cellular Biology, Biophysics, Biochemistry, Immunology, Virology and Microbiology
- Developmental Biology, Embryology and Gerontology
- Endocrinology, Metabolism and Nutrition
- Musculo-skeletal and Physiology
- General Physiology and Pharmacology
- Renal, Fluid and Electrolyte Physiology
- Hematology



Preparing ESA's Pallets—Technicians in white perform checkout operations on two experiment pallets in the Operations and Checkout Building High Bay area at the Kennedy Space Center. The pallets were built by the European Space Agency for their Spacelab Project.



Slated for OFT 4—Equipment assemblies are installed on one of the European Space Agency's pallets, this one due for use on Orbital Flight Test 4. The ESA devices, with various experiments mounted on their housings, will be carried in the cargo bay of the Space Shuttle.

- Cardiopulmonary and Stress Physiology
- Cardiovascular Physiology and Clinical Medicine
- Vestibular System and Neurophysiology

The 78 principal investigators are from U.S. and foreign universities, private and government organizations and the NASA scientific staff. Foreign countries involved are Australia, Switzerland and the United Kingdom. Each country is responsible for funding its own investigators.

Spacelab is a pressurized Space Shuttle system element designed to be operated by a payload specialist team of up to four persons. It is estimated that 15 to 20 investigations can be accommodated in each life science Spacelab mission. The two missions are planned with an 18-month launch interval, with the first launch scheduled for mid-1983. A few additional life science investigations are expected to go on other Shuttle missions during the same time period. The life science investigations must comply with flight safety requirements and engineering and management practices specified in NASA guidelines.

Spacelab, funded and built by the European Space Agency, will be carried to and from orbit by the Space Shuttle and remain attached to the orbiter throughout each flight. Spacelab will serve as a laboratory for life science and other investigations in near-Earth orbit for a period of one week to 10 days.

With the advent of the Space Shuttle and availability of standard, space-qualified hardware which can be placed in orbit, repaired, retrieved or replaced, NASA plans to use this capability to reduce payload costs, while making space flight more accessible to a wider range of users.

Tracking and Data Acquisition Changes

NASA plans to change its space tracking and data acquisition activities when the Space Shuttle and the Tracking and Data Relay Satellite System become operational in the 1980s. The plans are a result of a review of responsibilities at NASA's Goddard Space Flight Center, Greenbelt, Md., for tracking and data systems activities. The changes are intended to insure that tracking stations and network operations will be managed most efficiently and effectively using both government and contractor personnel and resources.

The Tracking and Data Relay Satellite System in 1982 will take over all of the tracking and data acquisition support of low Earth-orbiting spacecraft. At that time, the Spaceflight Tracking and Data

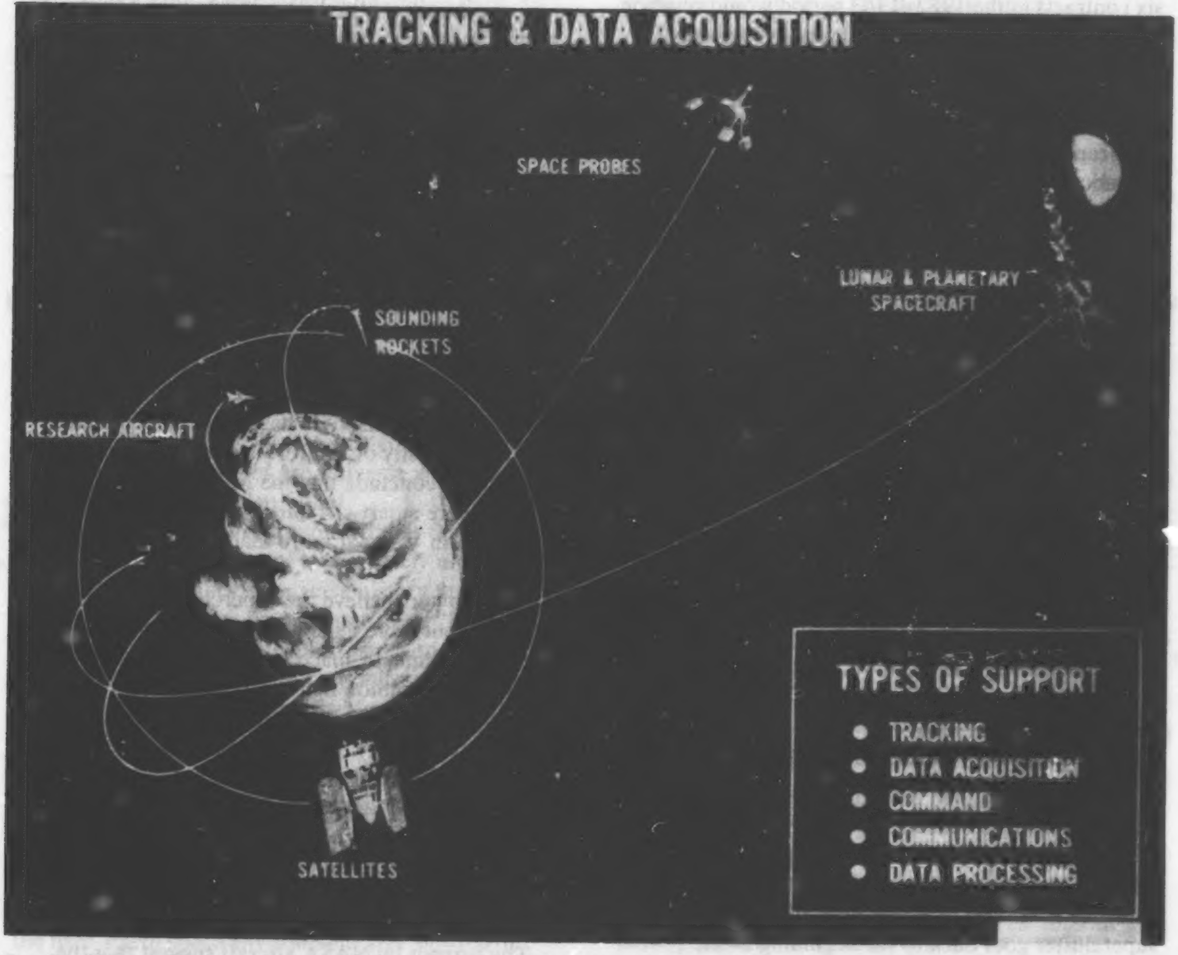
Network, NASA's worldwide network of tracking stations, will be closed, with the following exceptions:

- The Alaska station will be retained until Landsat 3 becomes inoperative, anticipated in 1984.
- The Goddard station will be retained until the International Ultraviolet Explorer spacecraft becomes inoperative, anticipated in the mid-1980s.
- The Merritt Island, Fla., and Bermuda stations will be converted to launch support and range safety facilities.
- The Goldstone, Calif., Australian and Spanish stations will be retained for support of geosynchronous and highly elliptical orbit spacecraft.

The Rosman, N.C., facility expects to cease operations in January 1981. The facility had been supporting the Applications Technology Satellite 6, which is no longer operating, and the Orbiting Astronomical Observatory, which will complete its mission in November 1980. The Rosman station is operated for NASA by the Bendix Field Engineering Corp., which employs about 120 people at the site.

The stations to be closed in 1982 include Hawaii; Guam; Quito, Ecuador; and Santiago, Chile. The station in Winkfield, England, will be closed in 1980.

The Spaceflight Tracking and Data Network capabilities of the Goldstone, Australian and Spanish stations are similar to those required for the Deep Space Network stations at the same locations. Combining the capabilities at each station will achieve more efficient use of the facilities, and save money.



Due for Change—The decade of the 1980s will see this basic system revised with the advent of the Space Shuttle and the Tracking and Data Relay Satellite System. At present, the program's prime responsibility is to provide tracking, data acquisition and processing, command and communications support to meet the requirements of all NASA flight projects. The new system will reduce and combine some facilities and will rely on both government and contractor support.

The facilities at Goldstone, Australia and Spain will be consolidated into a network under management of NASA's Jet Propulsion Laboratory, Pasadena, Calif., in 1983–1985.

Ten years ago there were approximately 1,200 Civil Service employees in the development, implementation and operation of tracking and data systems at Goddard for support of both manned and unmanned spacecraft. Since then, many of the functions have become routine contractor operations so that today, approximately 650 Civil Service people are assigned to tracking and data systems work, including the management and coordination of some 30 operations contracts.

The Goddard review has shown that consolidation and restructuring of the contracts into approximately six contracts in the 1982–1983 period would result in a more effective and efficient blend of government and industry performance.

The government work will focus on mission planning, technology development and systems engineering. Contractors will be responsible for operational tasks. As a result, the Civil Service complement devoted to tracking and data systems at Goddard will be reduced between 1980 and 1986 by about 225, at a rate of about 35 to 40 each year. At the same time, Civil Service personnel requirements in other Goddard programs are expected to increase at about the same rate and the displaced tracking and data employees can move into the new positions.

About 5,300 contractor personnel are employed in Goddard tracking and data system work around the world. The effect of these actions will be to reduce this number over the next five years by about 2,300, including 900 in the Washington-Baltimore area and 1,400, 500 of whom are foreign nationals, at Space Tracking and Data Network facilities around the world.

Huge Cluster of Galaxies Suggested

Using data obtained from high-flying NASA aircraft, scientists believe they may have discovered the largest cluster of galaxies—groups of hundreds of millions of stars—ever known. And if the indirect evidence is correct, the existence of the suspected supercluster goes back to the beginning of the universe.

This evidence for the supercluster comes from analysis of measurements from NASA U-2 aircraft of the cosmic microwave background radiation left over from the Big Bang*.

Synthesis of the Solar System—From NASA spacecraft, these images of six of the planets in the solar system and the Earth's moon were taken. Individual pictures were pieced together to show a complete area. The picture mosaic consists of: foreground—the Earth rise over the lunar surface with the sun flare on the edge of the Earth's limb. First planet shown above the Moon is Venus; top left to right are the planets Jupiter, Mercury, Mars and Saturn.

In 1978, a NASA-University of California at Berkeley team used the instrumented aircraft operated by NASA's Ames Research Center, Mountain View, Calif., to survey remnants of such radiation in the entire Northern Hemisphere sky. A similar survey of the Southern Hemisphere has just been completed.

The University of California scientists used this U-2 data to conclude that the Milky Way Galaxy—of which we are a part—is hurtling toward the constellation Virgo at more than a million miles an hour.

Astronomers believe the supercluster contains 30 to 40 percent more galaxies than normally found in the same volume of space, and that it may stretch across some 2 billion light years of space. When compared to the 10 billion-light-year-diameter of the observable universe, the supercluster would encompass 1 percent of the volume of it.

Dr. George Smoot of the University of California noted that not enough time has passed since the Big Bang for such a supercluster to have formed. This means that such a gigantic concentration of mass could go back to the beginning of the universe.

The surveys by NASA aircraft suggest that the event which started the universe about 15 billion years ago was extremely regular; that is, a powerful but tightly controlled expansion with matter moving outward in all directions at an equal rate.

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* The primordial explosion which many scientists believe began our universe.

Now comes the possibility of the supercluster and, "if we have one such huge concentration of matter," says Smoot, "there are probably others." This implies that at the time of its formation, the universe was "lumpy"—that the primordial fireball itself was lumpy instead of being extremely smooth as measurements by the same researchers and others such as Rainer Weiss of the Massachusetts Institute of Technology and David Wilkinson of Princeton University had previously suggested.

The work of other astronomers has contributed to the suspicion of "something unusual in this part of the sky," Smoot said. X-ray astronomy studies by A. C. Fabian, Cambridge University, and R. S. Warwick, University of Leicester, have found indications of a large-scale structure in the direction of Virgo. J. A. Tyson and J. F. Jarvis of Bell Laboratories have made automated counts of faint galaxies on long-exposure photographic plates and have found evidence of a northern supercluster of galaxies—far more than in any other part of the sky surveyed.

Scientists are surprised at the evidence for a cluster billions of light years in diameter. Said Smoot: "It boggles the mind that such a structure could exist—a big fraction of the observable universe." Apparently there is only one such collection of mass relatively close to us. Others, however, may be found at great distances. Despite the possible existence of the supercluster, the mass of the universe appears, on the average, to be evenly distributed.

Smoot is somewhat disappointed that the finding could disrupt the pattern of a completely uniform Big Bang because a uniform universe history fits very well with recent work on subatomic particles. "It is a paradox," he said, "that the universe is so uniform, but yet it appears to contain non-uniform structures on very close to the largest possible scale."

Proposals for Sun-Earth Probes

Scientists are being approached to propose experiments for a program of coordinated satellite measurements designed to provide a better understanding of the near-Earth space environment and Sun-Earth relationships. The program, called Origins of Plasmas in the Earth's Neighborhood, would attempt for the first time to examine the collective behavior of specific components which make up the geospace system—the near-Earth interplanetary medium, magnetosphere, ionosphere and upper atmosphere.

An understanding of this system is a prerequisite to understanding Sun-Earth relationships and their effect on our planet's environment, including short- and long-term weather and climate prediction and the impact of solar phenomena on communications. Current understanding, gained from previous satellite programs, clearly shows a high degree of interaction between all geospace components.

Basically, the program's aim is to investigate the flow of mass, momentum and energy through the solar wind and electrified environment near Earth, using instrumentation for remote sensing and closeup measurements of electromagnetic radiation, fields, particles and plasmas (electrified matter).

The program calls for simultaneous observations from a minimum of four spacecraft, placed in specific key regions of space and operating in widely different orbits. The satellites, launched by the Space Shuttle over a one-year period in the mid-1980s, would be placed to observe each of the major geospace plasma source regions (solar wind, ionosphere) and storage regions (ring current, plasma sheet, distant geomagnetic tail).

Each spacecraft would have significant orbit-change capability to provide observational flexibility and permit exploration of a vast volume of geospace. The spacecraft would operate for at least four years.

Although the program has not been authorized by Congress, scientists are being asked to submit their proposals by March 15, 1980, in order to ensure maximum scientific participation in the program and design of the spacecraft.

Objectives of the proposed mission would be to:

- Understand the physical process controlling the origins, entry, transport, storage, acceleration and loss of electrified matter, and electrical current in the Earth's neighborhood.
- Understand cause-and-effect relationships among the closely coupled solar wind, magnetosphere (the magnetic envelope that surrounds Earth) and the ionosphere (the electrified part of the atmosphere).
- Trace the flow of matter and energy through the geospace system from their interplanetary or atmospheric origins to ultimate deposition into the atmosphere or loss to the interplanetary medium.
- Assess the importance to Earth's environment of variations in energy deposition into the atmosphere caused by plasma processes.

- Utilize the unique capabilities of the program for solar wind and other studies.

This will be the first program to address the geospace environment as a whole. Past observations have been obtained primarily by single-point satellite measurements, and more recently by multi-point satellite measurements designed to study the linkage between no more than two geospace components.

Program management will be the responsibility of the Solar Terrestrial Division of NASA's Office of Space Science, Washington, D.C. Project management is expected to be assigned to NASA's Goddard Space Flight Center, Greenbelt, Md.

First Flight for Pivot-Wing Aircraft

First flight of the manned NASA Oblique Wing Research Aircraft took place on Dec. 21 at NASA's Dryden Flight Research Center, Edwards, Calif. Called the AD-1 for NASA Ames-Dryden, the research aircraft employs a pivoting-wing concept which could reduce noise and lower fuel consumption of future high-speed, transport-type aircraft.

Analytical and wind tunnel studies conducted by Ames Research Center, indicate that future oblique wing transport aircraft flying at 1,600 kilometer per hour might achieve twice the fuel economy of more conventional swept-wing transport aircraft.

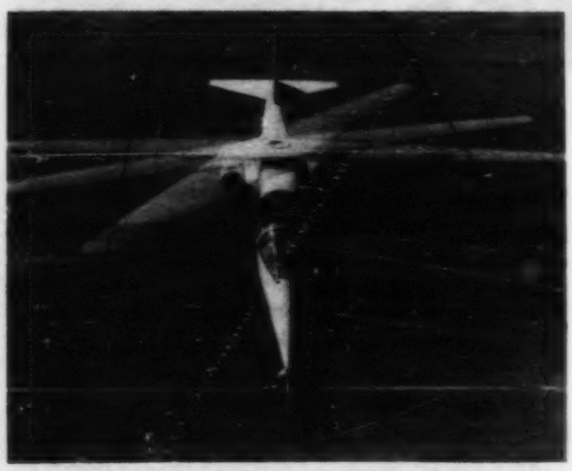
At lower flight speeds, the wing would be oriented at right angles to the fuselage, providing efficient, quiet operation for takeoff and landing as well as for low-speed cruise flight. The concept offers good low-speed stability and control characteristics and does not require complex high-lift systems. The engine thrust required for take off would be substantially reduced and could result in quieter operations in the terminal area.

For high-speed flights, the wing would be pivoted fore and aft to form oblique angles up to 60 degrees with the aircraft's fuselage. Studies indicate that this "scissor-wing" concept would permit better high-speed flight performance. As the aircraft flies faster, pivoting the wing to an oblique angle would decrease air drag, permitting increased speed and longer range for the same fuel expenditure.

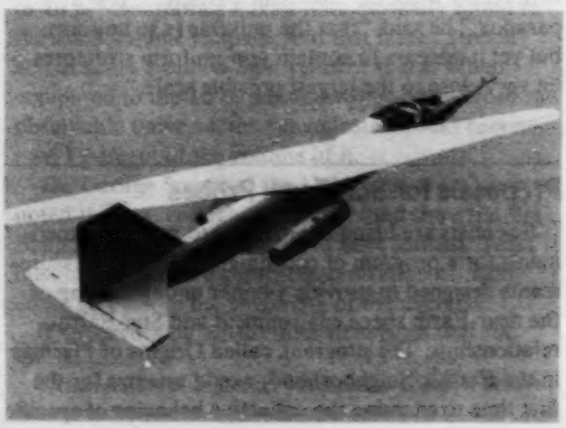
Because the concept is a significant departure from conventional aircraft design, NASA has initiated a low-cost exploratory program to study the fundamental low-speed operations of such an aircraft using this small, lightweight, manned test aircraft. Tom McMurtry, pilot, was at the controls for the first flight.

The research aircraft is approximately 12.2 meters long, with a wingspan of 9.7 m. Powered by two small 99.8 kilogram thrust turbojet engines, the AD-1 has a gross weight of approximately 907 kg and will be capable of speeds in the 241–354 km/hr range.

For the first flight, the wing remained perpendicular to the aircraft fuselage. On later flights, the wing can be pivoted from zero to 60 degrees while in flight. The aircraft was built by the Ames Industrial Co., Bohemia, N.Y., under a $240,000 fixed-price contract with NASA Dryden.



Attitudes of the Oblique Wing—The AD-1 research aircraft flew at the Dryden center in mid-December, initiating low and high speed testing of its pivoting oblique wing. In the top picture, a triple exposure shows three different wing positions of the small aircraft—0, 30 and 60 degrees of wing swing. At lower flight speeds, the wing is oriented perpendicular to the fuselage, providing efficient, quiet operation for takeoff and landing. The wing is pivoted fore and aft in high speed flight to form oblique angles up to 60 degrees with the aircraft fuselage, permitting increased speed and longer range for the same fuel expenditure.



Young Named Goddard Center Director

A. Thomas Young has been named director of the NASA Goddard Space Flight Center succeeding Dr. Robert S. Cooper who left government service in June. Young, deputy director of the NASA Ames Research Center, has been with the agency since 1961, when he joined the NASA Langley Research Center. While at Langley, he was mission director for the Viking exploration of Mars and was mission definition manager of the Lunar Orbiter Project.

Young served as director of the planetary program in the Office of Space Science at NASA Headquarters in Washington from November 1976 to February 1979, when he was named deputy director of Ames. He received NASA's highest award, the Distinguished Service Medal, in 1977 and is a member of the American Institute of Aeronautics and Astronautics and a fellow of the American Astronomical Society.

Young, born in Nassawadox, Va., earned bachelor's degrees in aeronautical engineering and mechanical engineering from the University of Virginia in 1961. He was a Sloan Fellow at the Massachusetts Institute of Technology in 1971–72 and received a master's degree in management.

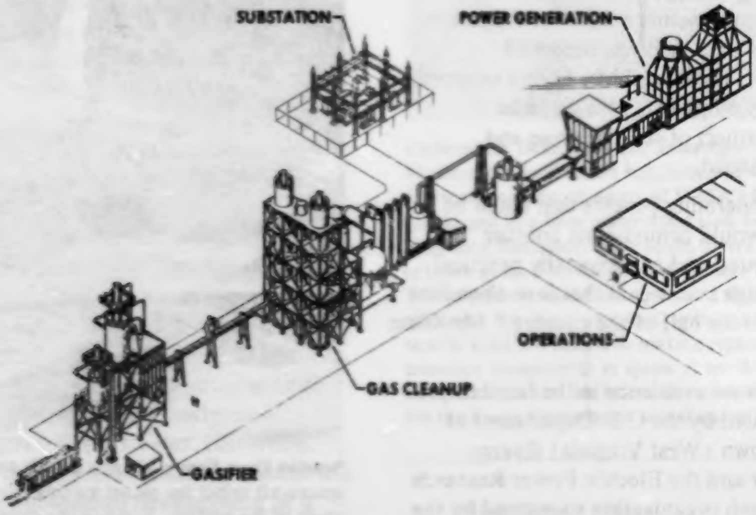
Study of Unique Power Plant

Lewis Research Center and The Cleveland Electric Illuminating Company have agreed to cooperate in a feasibility study that has broad implications for both the electric power and high sulfur coal industries.

If results of the study confirm expectations, a unique plant could be built at Lewis to generate heating and process steam and simultaneously produce electricity. The plant would represent an attractive option for the highly efficient use of high sulfur coal with minimal environmental impact. The plant could be the first in the world to combine coal gasification, integrated combined-cycle power generation and generation of steam.

Announcement of the study was made jointly by Dr. John F. McCarthy, Jr., Lewis Director, and Robert M. Ginn, President of The Illuminating Company. By controlling the air or oxygen flow and temperature, the plant would convert high sulfur coal into a clean fuel gas. Pollutants in the gas would be removed by one of a number of processes already commercially available. The clean gas would be burned to drive a gas turbogenerator to produce electric power. Waste heat from the gas turbine would be recovered and used to produce steam, which would be used for heating or for additional electric power generation in a steam turbogenerator.

During those periods when the waste heat can be used fully, the plant could approximately double the



GASIFIER ALTERNATIVE POWER PLANT CONCEPT

Artist's concept of coal gasification plant for the Lewis center amount of energy extracted from each ton of coal compared with conventional methods of electric power generation alone.

The feasibility study will be conducted under contract by the Cleveland-based international engineering firm of Davy McKee Corporation. If the six-month, $200,000 study confirms expectations, and assuming funding availability, design of the facility could begin in 1981. The concept of the plant is such that startup of the operating phase could then be achieved in 1984.

"We envision the plant as a fully working facility, not simply a demonstration plant to prove new technology," Dr. McCarthy explained. "In operation, it would supply our baseload electrical needs at Lewis plus steam for heating and process requirements. At the same time, we intend that the plant would demonstrate operating techniques and provide results that can be broadly applied throughout the electric power industry and other industries for heat energy or power needs."

"The potential operating benefits of such a plant on a commercial scale would be to assist in keeping costs to industry and the consumer at the lowest possible levels consistent with our national need to improve our environment and reduce our dependence on imported energy," Dr. McCarthy added.

CEI's electric utility specialists will provide guidance on technical and economic aspects and overall evaluation of the feasibility study. "Our team will be working with their Lewis counterparts on matters such as long-term reliability, operating practices, CEI's requirements in terms of the future interests of its customers, and relations with government agencies involved," Mr. Ginn explained. "The Illuminating Company is pleased to be associated with a project of such promise and potential," he continued.

"In addition to operating benefits that could be derived, the plant would demonstrate another environmentally sound and economically practical way to utilize the high sulfur coal that is so abundant in Ohio and the eastern half of the country," Mr. Ginn added.

Additional technical assistance in the feasibility study will be provided by the U.S. Department of Energy's Morgantown (West Virginia) Energy Technology Center and the Electric Power Research Institute, the research organization sponsored by the nation's electric utilities.

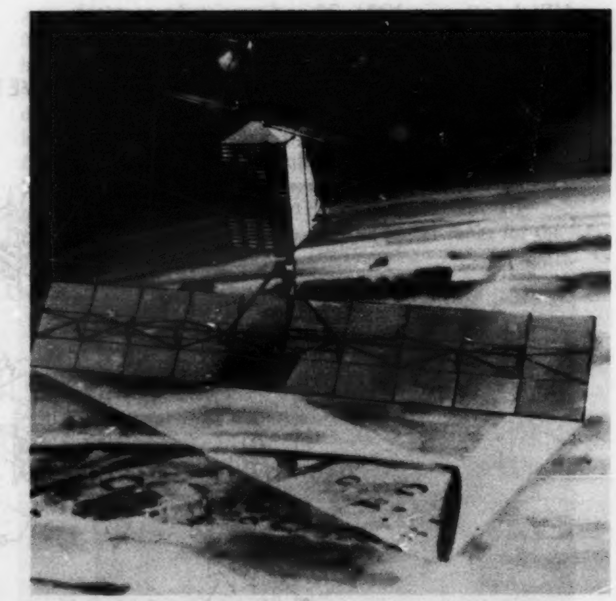
Radar Mapping of Venus

The Jet Propulsion Laboratory in Pasadena has selected Martin Marietta Aerospace, Denver Division in Colorado, and the Space and Communications Group, Hughes Aircraft Co., El Segundo, Calif., to conduct studies which could lead to development of an unmanned NASA spacecraft to make topographical radar maps of Venus in the mid-1980s.

When the $500,000 study contracts are completed next summer, one of the two companies may be chosen to develop the Venus Orbiting Imaging Radar (VOIR) spacecraft if the mission is approved by Congress.

Planned for a Space Shuttle launching and five-month trip to Venus, the spacecraft would first be placed in a 300 by 19,000-kilometer Venutian orbit for a two-month gravity study of the planet.

The craft's orbit would then be circularized at 300 km for a 120-day radar mapping sequence, which would cover nearly all the surface of Venus at low resolution 1.0 km and about 2.5 percent at high resolution, 100 meters. The primary mapping instrument aboard the spacecraft will be a side-looking synthetic aperture radar similar to one flown in 1978 aboard NASA's experimental oceanographic satellite, Seasat.



Soaring Over Venus—In this artist's conception, the VOIR spacecraft orbits the planet gaining data for a topographic study of the surface. Venus is the closest neighbor of Earth inbound toward the Sun.

Marshall Man Wins Excalibur

Frank J. Nola of the Marshell Space Flight Center was chosen as one of the first recipients of the Excalibur Award, a new citation created to honor civilian and military personnel of the Federal Government for their contributions. Nola was chosen by a select committee of seven persons from outside the executive branch of government, a group formed by Rep. Michael D. Barnes, D-Md. Presentation of the award to the NASA official was made at the U.S. Capitol and the Excalibur Award certificate was signed by the Speaker of the House, Rep. Thomas P. "Tip" O'Neill. Nola was cited for his design of the Power Factor Controller, a simple and inexpensive device expected to produce substantial savings of energy in the operation of electric motors.

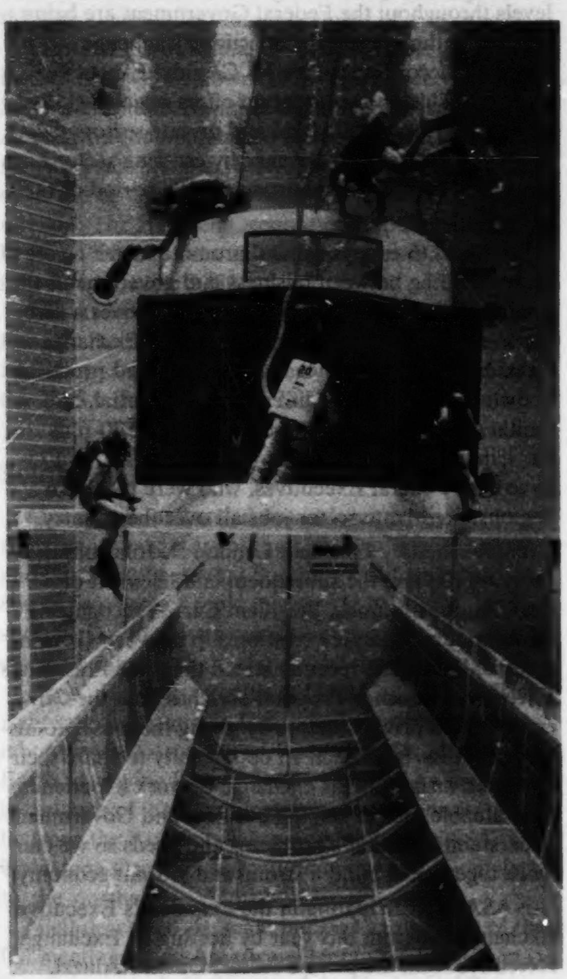
Solar Electric Propulsion System

Two companies have been selected to receive parallel contracts for design definition studies of a new Solar Electric Propulsion System that would become an integral part of the NASA Space Transportation System. Contracts, valued at $1.15 million each, will be awarded to Boeing Aerospace Co., Seattle, Wash., and Lockheed Missiles and Space Co., Sunnyvale, Calif. The work will be performed over the next 12 months.

Solar electric propulsion technology has been under development by government and industry since the early 1960s. Its very efficient propellant usage, long continuous operating lifetime, and use of solar energy to provide electric power, make it especially suitable for rendezvous with comets and asteroids, delivery of probes to planets in the outer solar system, close observation of the Sun and extended duration operations in Earth orbit. The Solar Electric Propulsion System is a candidate for use on a number of upcoming U.S. planetary and Earth-orbital investigation.

Responsibility for definition and development of the new propulsion system has been assigned to NASA's Marshall Space Flight Center, Huntsville, Ala. Completion of these system definition studies will provide the basis for subsequent development of a flight system.

Other companies competing for the studies were Hughes Aircraft Co., El Segundo, Calif., and Rockwell International, Downey, Calif.



Underwater Drill for Space Telescope—Astronaut Bruce McCandless, in pressure suit, is shown working with a full-scale mockup of a part of NASA's Space Telescope, submerged in a huge water-filled tank called the Neutral Buoyancy Simulator. Four scuba divers stand by during the exercise at the Marshall Flight Center. The unmanned Space Telescope is designed to be serviced in orbit and Marshall engineers use the water environment of simulated weightlessness to train astronauts in making repairs and changing telescope components in space. A mockup of the Space Shuttle Orbiter cargo bay lies below the work site. Proposed launch for the Space Telescope is sometime in 1984.

Federal Executives Sought for Presidential Exchange

High-calibre executives at the GS-13, 14, and 15 levels throughout the Federal Government are being sought for the President's Executive Exchange Program, according to Lee M. Cassidy, Executive Director. This unique program offers selected skilled executives from the Federal and private sectors the opportunity to gain experience by crossing sector lines for a year during the important middle period of their careers.

Designed to encourage and promote better understanding between business and government, the program provides the participating executives a rare experience in professional growth. Each Exchange Executive has the chance to gain first-hand practical knowledge of the procedures, goals, potential, and limitations of the opposite sector. Of the 500-plus participants since the first program in 1970–71, 175 have been Federal Executives, who were placed in responsible private sector jobs all over the country.

Established by President Lyndon B. Johnson, the Program has had the subsequent endorsement of three Administrations. President Carter, recognizing the continuing complex relationship between Government and business, recently stated that "the President's Executive Exchange Program enriches both the Government and private sectors by giving the most promising executives from each an opportunity to share their ideas and insights. This exchange of work experience is a valuable tool in helping business and Government understand the other's problems and needs so we can work together to build a strong and vibrant economy."

NASA is participating in the President's Executive Exchange Program this year by hosting an Exchange Executive from the private sector. David Reduzzi, who has been a Marketing Specialist for the Ford Motor Company, is the Special Assistant to the Director for Energy Systems at NASA for the Exchange year.

To assure the continued high quality of the participants, an evaluation is made of leadership qualities, initiative and management ability, and the potential for the Senior Executive Service. Prior to final approval by the agency or department head, nominees must be screened by their personnel officer and Executive Resource Board.

Nominations for the coming Exchange year beginning September 1980 are due not later than April 15, 1980. Potential candidates should direct their inquiries to either the personnel directors of their Federal agency or department, or to the President's Commission on Executive Exchange, P.O. Box 14179, Washington, D.C. 20044, (202) 632–6834.

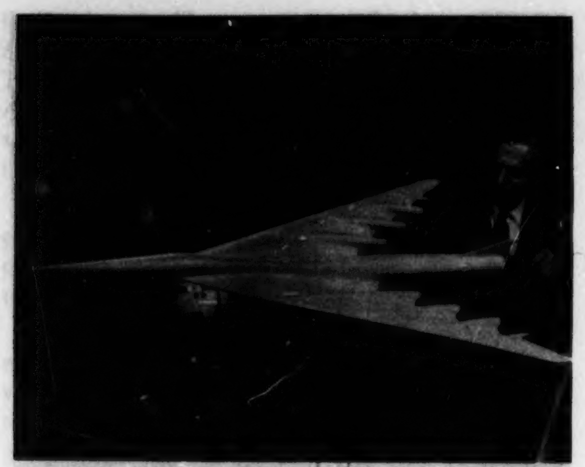
"Right Stuff" Reassembled—An upcoming television special on the X-15, the research aircraft that took America to the edge of space, brings together its former pilots at Dryden Flight Research Center. From the left are A. Scott Crossfield, first to fly the X-15, Adm. Forrest "Pete" Peterson, now chief of Naval Air Systems Command, Col. Joe Engle, now backup Astronaut for the Space Shuttle, and Harrison Storms, formerly of North American Aviation. Other Dryden pilots interviewed were Fitzhugh Fulton, William Dana and Milton O. Thompson.

Investigators Selected for Climate Studies

NASA planners have selected 33 scientific investigations for four satellite missions during 1982 through 1985. The investigations, 23 from the United States and 10 from six foreign nations, will be concerned with climate and upper atmospheric research.

The 23 U.S. investigations have been selected from 11 universities, one private organization and two government agencies. The foreign countries involved are: Canada, Japan, France, United Kingdom, Federal Republic of Germany and Italy.

Along with the 33 principal investigators, more than 80 co-investigators are associated with the selected investigations. More than 80 responses were received by NASA from the world's scientific community in reply to an announcement last January.



Langley Scientist Honored—Dr. Richard T. Whitcomb of the Subsonic-Transonic Aerodynamics Division, Langley Research Center, has received the Howard N. Potts Medal for contributions in applied science, presented by the Franklin Institute in Philadelphia. Dr. Whitcomb, shown inspecting a supersonic plane model, was recognized for his work in the development and application of the area rule concept, the supercritical wing and winglet.

The 33 principal investigators will be organized into three teams and will initially participate with NASA through scientific studies and investigations in support of the development of three experiment instruments. Each country will be responsible for funding its own investigations and its participation in support of instrument development. Costs of the U.S. investigations are expected to total about $55 million over the next five years, including NASA-developed instruments.

The Earth Radiation Budget Experiment and the Stratospheric Aerosol and Gas Experiment II will investigate the spatial and temporal variations of the radiation budget and stratospheric aerosols respectively. The Stratospheric Aerosol and Gas Experiment II and Halogen Occultation Experiments will each investigate ozone variability and the latter will focus on the effect of halogens on ozone along with other upper atmospheric constituents and physical processes.

All three experiments will be flown on the Earth Radiation Budget Satellite. The satellite will be carried to a medium inclination orbit by the Space Shuttle and released as a free-flyer for its two-year scientific mission.

After instrument development, the investigators will plan for orbital operations, data processing, investigating instrument performance, verifying the adequacy of data products and completion of individual initial scientific data use investigations. Additional data use investigations may be sought through a subsequent announcement of opportunity.

Identical Earth Radiation Budget Experiment instruments will be flown on two near-polar orbiting, Sun-synchronous National Oceanic and Atmospheric Administration operational meteorological satellites for two-year missions to complement the data coverage of the Earth Radiation Budget Satellite mission. The Halogen Occultation Experiments will be flown initially on a seven-day Spacelab 3 mission scheduled for late 1982.

The science activities will be managed by the Langley Research Center and the overall project, including satellite development, will be managed by the NASA Goddard Space Flight Center.

Southern California Land Area Expanding

Measurements carried out independently by research investigators of the U.S. Geological Survey and NASA indicate that Southern California has entered a phase of rapid increase in its area of land surface. Radio noise from distant quasars—powerful celestial objects—helped pinpoint the change.

Dr. A. E. Niell, scientist at NASA's Jet Propulsion Laboratory, Pasadena, Calif., and member of the laboratory's Astronomical Radio Interferometric Earth Surveying Project Team, reported an increase in distance of 20.3 centimeters in seven months between the Pasadena laboratory and the NASA Goldstone Deep Space Station, about 193 kilometers to the northeast.

Niell described the team findings at a session of the fall meeting of the American Geophysical Union in San Francisco. J. C. Savage of the Geological Survey reported, in the same session, results which are consistent with the project team's measurements.

The project team's method of measurements involves recording radio noise from distant quasars simultaneously at the two radio telescope locations. By comparing the time of arriving signals, using extremely precise clocks, changes in distance between the telescopes from one survey to the next can be measured to accuracies of 5 cm or less. The techniques have been developed to the point that such measurements can be used to detect strains over large blocks of the Earth's crust and may have important application to the earthquake prediction mission of the Geological Survey.

Between 1974 and 1978, Geological Survey crews measuring some 250 lines of about 32 km each in length found that all the changes in length recorded were consistent with a uniform north-south contraction of South California. The lines are measured to an accuracy of better than 1 cm using laser beams.

Since 1978, however, the pattern has changed with networks of lines in the Salton Sea and Coachela Valley areas showing extension east-west. At Palmdale, Calif., about 56 km north of Pasadena, the transition from north-south contraction to extensional strain has been more dramatic. Between May and October of this year the land surface has expanded in area by about 2 parts per million. Over an area of about 24 by 32 km the change would amount to the addition of a quarter acre of land to the Palmdale area in six months.

The extension of 20.3 cm over the distance from Pasadena to Goldstone is in approximate agreement with the laser measurements but suggests that the area of expansion may be much larger, perhaps extending over 161 km to the northeast.

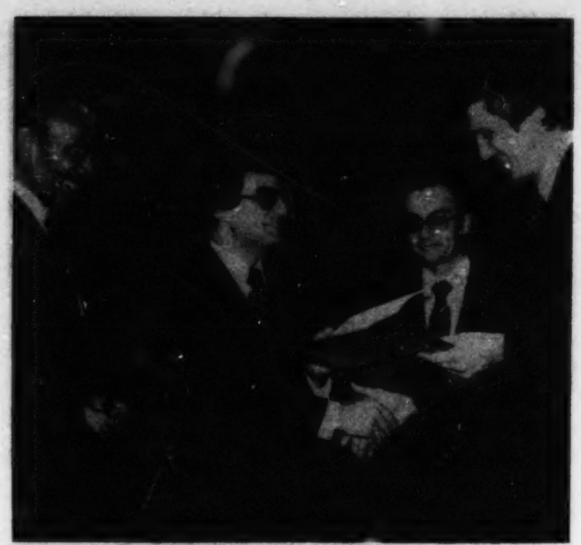
There is the appearance from NASA project team data that a similar episode of extension occurred in 1975. However, Geological Survey networks along the San Andreas Fault throughout Southern California showed opposite data, that of compression.

The period over which such precise measurements have been made is less than a decade. From such a short period of data acquisition, scientists are as yet unable to determine whether or not the present pattern is simply one phase of a cycle of compression or expansion.

The suddenness and size of the expansion is intriguing, but as yet, not well understood. There have been other hints in recent years that such large regions of the Earth's crust deform episodically but the six-month period of this large extensional distortion is considered remarkable.

The implications for future earthquakes are speculative and scientists such as Dr. Barry Raleigh of the Geological Survey are prepared only to say that the present pattern of straining, if it persists, is likely to lead to a large earthquake on the San Andreas Fault much sooner than would the earlier pattern of north-south contraction.

Both the Geological Survey and NASA, which sponsor the team project, have increased the frequency of measurements in the area and plan continued close cooperation in these studies.



White House Recognition—Thomas E. Pinelli, second from left, receives a Certificate of Appreciation and Letter of Commendation from Richard M. Harden of the Executive Office of the President, right, for his work in the 1978–79 NASA Career Development Program. Pinelli is from the Langley Research Center, where he is Assistant to the Chief, Scientific and Technical Information Programs Division. Assisting in the presentations were Carl E. Grant, left, Director of Personnel at NASA Headquarters and John Heiss, a personnel officer from the White House.

Advanced Gas Turbine Engine for Autos

A $56 million federal letter contract has been awarded to an automotive industry team headed by AiResearch Manufacturing Company of Arizona, Phoenix, a division of the Garrett Corp., Los Angeles, to develop an advanced gas turbine engine for automobiles as an attractive alternative to the current spark-ignition (internal combustion) engine.

Work performed under this contract represents one of several awards in this phase in a Department of Energy effort with the auto industry to develop the gas turbine as a fuel-saving, multifuel-capable and environmentally safe automobile engine.

The award was negotiated by NASA's Lewis Research Center, Cleveland, which manages several portions of the Department of Energy's highway vehicle systems program including the automotive gas turbine segment. The AiResearch Manufacturing team includes subcontractors Ford Motor Co., Dearborn, Mich.; AiResearch Manufacturing Company of

California and AiResearch Casting Co., both of Los Angeles; and Carborundum Co., Niagara Falls, N.Y. The contract is of the cost-shared, no-fee variety. The AiResearch gas turbine engine concept calls for a single-shaft gas turbine with a continuously variable type of transmission.

The gas turbine has a high potential for fuel efficiency and low pollution. It can run on a variety of petroleum and non-petroleum fuels and could help reduce the nation's dependence on oil.

The advanced turbine system to be developed is expected to use new structural ceramic materials which can withstand high operating temperatures. In the turbine, higher operating temperatures mean greater fuel economy. A large portion of the development effort will be in the area of ceramics.

The specific goal of the AiResearch advanced gas turbine effort, according to Energy and NASA officials, will be to develop and demonstrate by May 1985 an advanced automotive gas turbine powertrain system which when installed in a 1985 production vehicle (a 1,418-kilogram inertia weight vehicle) meets the following objectives:

- Combine cycle fuel economy of 36 miles per gallon based on Environmental Protection Agency test procedures and gasoline fuel;
- Gaseous emissions and particulate levels less than the most stringent federal standards being considered for the 1980s;
- Ability to use a variety of alternate fuels.

The intent is to demonstrate turbine technology in vehicles so that the auto industry can make an early decision on the potential of the gas turbine engine for mass production.

The Energy department's gas turbine program began in 1972 under a contract between the Environmental Protection Agency's clean air program and the Chrysler Corp. It was successively incorporated into the Energy Research and Development Administration and the Energy department under subsequent reorganizations. The total federal investment in the program to date is about $18 million.

Several previous experimental turbine engines have been built and tested in cars under the program including the latest version, a 100-horsepower engine designed and installed in a compact Dodge Aspen body. This program is within Energy's Office of the Assistant Secretary for Conservation and Solar Applications.

Contractor News

Space Systems Group of Rockwell International Corp., of Downey, Calif., has agreed to modify its Shuttle Orbiter contract with the Johnson Space Center to cover integration of payloads and payload carriers. The amendment includes payload flight kit development, payload interface definition, systems studies, payload systems tests and evaluations and other payload interface hardware through December 1983. Value: an estimated $38 million.

General Dynamics Corp., Convair Division, of San Diego, has signed a contract with the Lewis Research Center for management and engineering services to support the Atlas/Centaur launch vehicles program. The cost-plus-award-fee contract of over $12 million will provide for the services in connection with Earth orbital missions during the period December 1, 1979 through December 31, 1980. Centaur, the nation's first high-energy, liquid hydrogen-liquid oxygen rocket vehicle is used as a second stage with the Atlas booster. Management and engineering support activities will be carried out principally at the Convair plant in San Diego and the Eastern Space and Missile Center in Florida.

The National Academy of Sciences in Washington, D.C. has won a $5 million contract modification for continued administration of NASA's Resident Research Associateship Program. The work, to be performed in Washington, calls for the recruitment, evaluation, selection and administration of some 235 additional U.S. and foreign postdoctoral researchers.

The American Institute of Aeronautics and Astronautics (AIAA) has been awarded a $2 million contract extension for continued support of the NASA Scientific and Technical Information Program. Under the terms of the modification, AIAA will continue to acquire significant reports of activities and events related to ongoing and proposed space programs, to analyze the information and publish it in the publication International Aerospace Abstracts.

McDonnell Douglas Astronautics Co., of Huntington Beach, Calif., has received a letter contract from Goddard Space Flight Center for fabrication and subassembly of vehicles for Delta launches 164 and 165. The agreement is an add-on to an existing fixed price contract and amounts to $2 million. The assembly work will be performed at the company's Huntington Beach plant and is to be completed in about 15 months.

Precision Fabricating & Cleaning, Inc., of Sharpes, Fla., has won a million dollar contract with the Kennedy Space Center extending through December 31, 1980. The firm will fabricate 16 different pneumatic control panels to be installed in the Space Shuttle Mobile Launcher Platform 2. The panels, ranging in size from 3 to 12 feet in length and 5 feet in height, are for the primary distribution and control of high pressure nitrogen and helium gas. The gases are to purge and pressurize the Space Shuttle vehicle and other systems on the platform before propellant loading operations and launch.

Goodyear Aerospace Corp., of Akron, Ohio, has been awarded a $4.7 million contract for fabrication of an ultra high-speed image processing computer called the Massively Parallel Processor. The computer will be installed at the Goddard center and used to extract data from the Earth resources and environment images received there, at present a time-consuming and expensive process. With the Parallel Processor, an image can be handled 10 to 100 times faster than is now possible, at greatly reduced cost. The agreement is a cost-plus-incentive-fee, Phase 2 contract, awarded to Goodyear after the firm's performance of an eight-month Phase 1 design contract on the project.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) and Employer	Title	Patent No.	Installation
Robert E. Frazer, Caltech/JPL	Apparatus for endoscopic examination	4,176,662	NRO/JPL
John M. Franke, LARC	Laser doppler velocity simulator	4,176,950	LARC
Marion L. Roberts Max H. Sharpe Albert C. Krupnick, MSFC	Aluminum or copper substrate panel for selective absorption of solar energy	4,177,325	MSFC
Salvatore R. Riccitiello Paul M. Sawko Carlos A. Estrella, ARC	Catalysts for polyimide foams from aromatic isocyanates and aromatic dianhydrides	4,177,333	ARC
Curt A. Levis, Ohio State University, Columbus, Ohio	Distributed-switch dicke radiometers	4,178,100	GSFC
Terry L. St. Clair Ann K. St. Clair, LARC	Crystalline polyimides	4,180,648	LARC

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January 17	Atlas Centaur	ETR	DOD Navy. Reimbursable
SMM-A	February	Delta	ETR	NASA. Scientific Solar Maximum Mission.
Intelsat V-A	September	Atlas Centaur	ETR	Intelsat communications. Reimbursable.
NOAA-B	April	Atlas-F	WTR	NOAA Weather. Reimbursable.
Intelsat V-B	December	Atlas Centaur	ETR	Intelsat communications. Reimbursable.
Navy-20	July	Scout	WTR	DOD Transit. Reimbursable.
GOES-D	August	Delta	ETR	NOAA Weather. Reimbursable.
Navy-21	October	Scout	ETR	DOD Transit. Reimbursable.

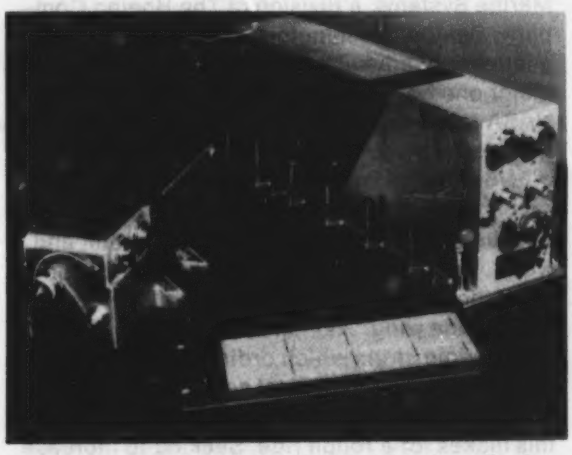
Did You Know?

The Applications Technology Satellite came to the rescue recently when a Pacific atoll was battered by the sea. ATS 1 provided disaster relief communications for the Pacific Trust Territories atoll of Majuro after sea waves swept over the island on November 30 and on December 2. Relief teams flown to the atoll reported 500 homes destroyed or damaged, 4,000 people left homeless and $1.8 million damage to the roads. Our ATS terminal was used to communicate through ATS 1 and the Denver, Colorado, terminal of the Public Satellite Consortium to the Federal Emergency Management Administration office in San Francisco. The terminal was on the atoll as part of a Department of the Interior experiment.

The Kennedy Space Center in establishing a special discretionary fund for pursuing innovative ideas in research and technology has also developed a systematic management approach for administering the program. After receipt of the Resources Authorization (Form 506) the funds are put into the KSC accounting system and identified by a specific code. All activity relating to the code is then closely monitored and the status of the study progress and funding is provided the Center Director monthly. In the event of numerous proposals, an ad hoc panel is convened to assist the Director in his review.

The Madrid Space Station, an integral part of the Deep Space and Spaceflight Tracking and Data networks, has been increasingly active in energy conservation and savings. Because Spain produces only 2 percent of the petroleum it consumes, station personnal began an aggressive energy savings program in 1974 and carried it through to the present. Heating and air conditioning systems have been redesigned, bus service combined, and lighting reduced. Future plans include installation of additional waste heat recovery systems for heating and cooling, replacement of incandescent lights with fluorescent and gas discharge fixtures and correction of the station electrical load power factor. All measures combined have resulted in the overall reduction of fuel at the Madrid Station from FY 1974 through FY 1979 of forty-seven percent, while the actual workload in terms of hours of support increased by thirty percent.

A Workshop to Develop a National College-Level Student Experiment Competition for the Space Shuttle was held at Headquarters in late November. The workshop was organized by the Forum for the Advancement of Students in Science and Technology (FASST) for NASA's Student Activities Steering Committee, chaired by Dr. Glen P. Wilson. Students from professional societies representing 170,000 members heard from Dr. Robert A. Frosch, who called their work, "essential and inherent to the task of the agency", and from former astronaut, Sen. Harrison Schmitt.



Shuttle's Compact Communications—At left is the radio, the size of a carton of cigarettes, that Space Shuttle crewmen will use when working in space outside the Orbiter. A "low profile" antenna for the astronaut unit is in the foreground and at right is a radio assembly that will be installed in the spacecraft. The small radios will provide the communications link between the Shuttle and any space walking astronauts, as well as contact with air traffic control towers and "chase" planes during the landing procedure back on Earth.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Smooth Passage For The Jetfoil

It is 260 nautical miles across the North Sea from Stavanger on Norway's west coast to Aberdeen in northern Scotland. That's a full day's travel for most conventional ships, a half day for the fastest. In 1977 a hydrofoil named the Flying Princess made a record breaking crossing in just six hours 11 minutes, underlining the speed and convenience that is attracting more and more travelers to hydrofoil transportation.

The Flying Princess is a Boeing Jetfoil,* one of a family of commercial waterjets built by Boeing Marine Systems, a division of The Boeing Company, Seattle, Washington. The new Jetfoil offers a number of advantages over earlier hydrofoils, a major one being a smooth ride in rough waters. NASA technology contributed to jolt-free passenger comfort.

Hydrofoils skim the surface at speeds considerably greater than those of conventional ships because there is little friction between hull and water. Hulls are raised above the water by the lift of the foils, which resemble and function like an airplane wing. The foils are attached to the hull by rigid struts which ordinarily cause a vessel operating in coastal seas to follow the contour of the waves. In wind-whipped waters, this makes for a rough ride. Seeking to increase passenger acceptance, Boeing Marine Systems engineers looked for ways to improve rough-water ride quality.

Langley Research Center conducts continuing ride quality research. Initially, it was later expanded to include all modes of transportation. Research includes studies of vibration, acceleration, temperature, humidity, passenger seats and posture, and the psychological aspects of passenger reaction to vehicle ride. As part of the program, Langley developed instrumentation, ride quality models and methods of data analysis. The University of Virginia, a Langley contractor, published a report on the subject and Langley held a Ride Quality Symposium.

A member of the Jetfoil development team attended the symposium and followed up by obtaining additional details of Langley's research. The NASA information led to Boeing's design of a computer-controlled system that automatically changes the pitch of the hydrofoils in response to changes in the water movement, eliminating much of the oscillation experienced by hydrofoils moving rapidly through rough water. The result, the company says, is rough-water ride quality unmatched by competitive craft.

The Jetfoil made its operational debut in 1975, operating across the South China Sea from Hong Kong to Macao. In the same year it entered service in the Hawaiian Islands and later, additional services were initiated in Venezuela, Japan and across the English Channel from London to Zeebrugge, Belgium.

NASA

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Space Administration

"For the benefit of all . . ."

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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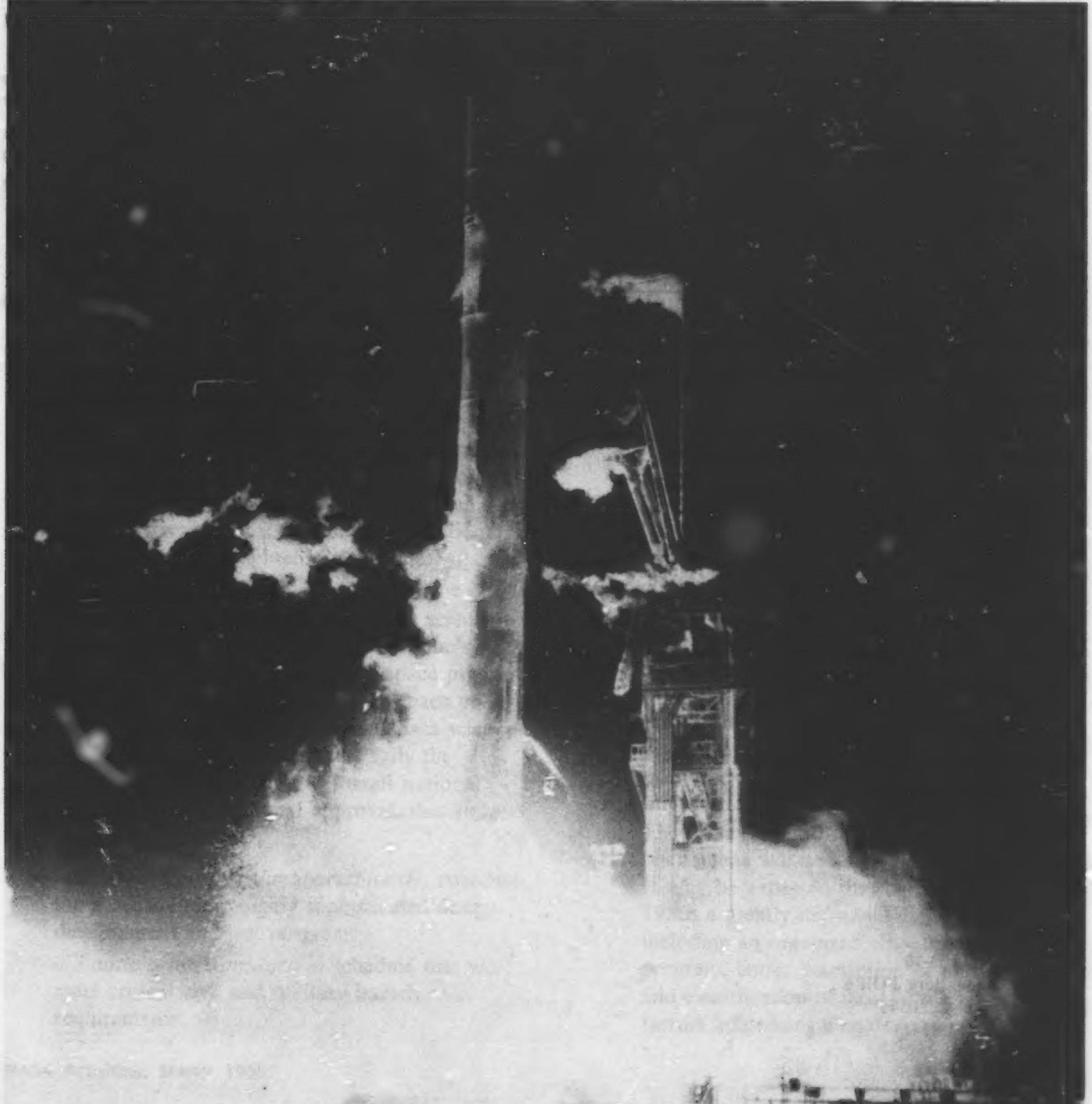

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Cover

First of the 80s—The third in a series of Fleet Satellite Communications satellites was the first NASA launch of the new year and the decade. On a clear night, at 8:26 p.m. EST, January 17, FLTSATCOM-C roared aloft from Cape Canaveral aboard an Atlas-Centaur rocket in a launch described as "near perfect". Headed for an apogee of 35,813 kilometers and perogee of 167.4 km, FLTSATCOM-C became part of the versatile communications system for U.S. military units throughout the world and is now controlled by the Air Force. Launch witnesses at the Cape, even those who had experienced the ascent of a Saturn V, called the FLTSATCOM departure a spectacular sight, with the vehicle glowing "like a star" until out of sight—good omen for the 1980s.

Correction—The research craft shown on the cover of the February Activities was a Drone Aeronautical Structural Test vehicle, not a HiMAT aircraft as described.

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Letter from Washington

Dear Colleagues:

The President's budget for NASA in fiscal year 1981 is a positive budget and one which moves us forward into the 1980s across a broad front of vital activities in space transportation, space science, and in the practical applications of space technology and aeronautics.

In the eighties we look forward to operational status for the Space Shuttle fleet; large increases in the use of satellites for communications and for remote sensing of land, ocean, and atmospheric conditions; continued improvement in performance, safety, energy efficiency, and environmental compatibility of aircraft; and dramatic new increases in our knowledge and understanding of the universe.

The President has proposed a NASA budget totalling $5.737 billion for FY 1981, and a fiscal year 1980 supplemental appropriation of $300 million for Space Shuttle development. This budget will build on NASA's basic strengths in a time of serious national economic stresses and heightening international tensions.

It provides significant initatives in space science and applications. It reflects the Administration's commitment to a strong, multi-faceted space program in the 1980s. It supports the President's space policy goals of maintaining U.S. leadership in space science and applications as well as exploiting fully the capabilities of the Space Shuttle for all national objectives. With Congressional approval, this budget will support:

—*initial test flights of the Space Shuttle*, culminating a decade-long, highly sophisticated design, development and test program;

—*a Shuttle orbiter production* schedule that will meet critical civil and military launch requirements:

—*continued emphasis on a broadly-based space science* program featuring:

- a new mission, the Gamma Ray Observatory (GRO), that will provide a major increase in our knowledge of the high energy universe and improve our knowledge of gamma ray source positions by a factor of 50 to 100, a powerful new tool for the study of high energy phenomena;
- development effort on the restructured 1984 Galileo mission, to capitalize on the superb performances of Voyagers I and II at Jupiter;
- continued work on the U.S. spacecraft for the 1983 U.S./Europe International Solar Polar dual spacecraft mission;

—*important emphasis on space applications*, including:

- focus of our Landsat land sensing effort to support the President's recent decision on implementing a fully operational satellite-based land remote sensing system under Department of Commerce leadership; this capability will allow enhanced forecasting of production of major crops, location of vital petroleum and mineral resources, and increased monitoring of environmental quality.
- initiation of the National Oceanic Satellite System (NOSS), a tri-agency flight program that will demonstrate operational global sea surface observation capabilities from space; NOSS will bring space remote sensing capabilities to the ocean, complementing similar capabilities over air and land. Global marine forecasting capability via improved weather satellites for support of maritime activities is also likely within the 1980s including optimum ship routing based on improved forecasting.

  Improved satellite-based forecasting of large general atmospheric circulation provides the basis for local weather forecasts, including forecasts of phenomena such as severe storms. The forecasting of these localized, near-time phenomena will be a focus of the 1980s.

  It may be expected that by the end of the 1980s a greatly improved data base will exist, including an organized climate monitoring program, better description of present trends, and identification of most of the important factors influencing climate.

- expanded communication satellite research and development studies and advanced technology for experimental wideband satellite communications. To enlarge a bit, the next decade of satellite communications will show as rapid progress as the past, which saw the creation of a global network of satellites and Earth stations connecting eighty countries on six continents. An educated guess as to the total expected demand for satellite circuits for present and projected new uses by the year 2000, including domestic and regional as well as international traffic, is that a better than ten-fold capacity increase is required. These new systems will exploit the Shuttle launch capability and will demonstrate a new class of satellites having more telecommunication capacity, high-speed digital transmission, and longer life.

—*In aeronautics we will* continue advanced work on more efficient and effective aircraft featuring:

- a comprehensive program of research and technology;
- vigorous flight test programs for the Tilt Rotor and Quiet Shorthaul Research Aircraft and for the Highly Maneuverable Aircraft Technology Vehicle;
- important new thrusts in technology for advanced rotorcraft;
- emphasis on advanced variable cycle engine technology, and;
- continued progress in aircraft energy efficiency technology for the next generation of transport aircraft, including a next step in advanced turboprop system technology. While technology is only one of several factors influencing the evolution of commercial aircraft, it is a key factor in that it directly affects equipment costs, operating costs, safety, comfort, fuel economy, and other primary considerations. As an example of the potential impact of improved technology, the free world market for new transport aircraft between 1980–1989 has been estimated to amount to over 5000 aircraft representing a total investment approaching $200 billion.

—continued application of NASA expertise to national energy problems;

—the necessary resources for our critical in-house scientific, technical and administrative staffs and facilities to assure successful programs in aeronautics and space.

I think you will agree from its highlights that the recommended budget for FY 1981 is more than adequate to move our agency ahead in its prescribed tasks of expanding human knowledge of the Earth, the solar system and the universe; of exploiting the special environment of space for the benefit of humanity; and of assuring continued U.S. leadership in space and aeronautical technology. I think you will agree also that it puts us on a solid and sensible course that will carry us into the most challenging and interesting decade yet in space and aeronautics.

Sincerely,

Robert A. Frosch

Robert A. Frosch

Budget Proposes Gamma Ray Satellite

The Gamma Ray Observatory, a proposed new start in NASA's fiscal 1981 budget, is designed to explore sources of gamma rays in space—the most energetic form of radiation known. The Earth-orbiting observatory, planned for launch in 1985, will carry instruments which will detect gamma rays in a variety of forms—very high energy gamma rays from pulsars, nuclear gamma rays and gamma ray bursts.

Information returned is expected to provide a much deeper understanding of the nature of supernovas, pulsars, quasars and radio galaxies, the character of the universe at an early time, and the possible existence of antimatter in the universe.

Scientists also hope to learn more about the incredibly dense matter which makes up such objects as neutron stars—matter so compressed that a teaspoonful of it would weigh millions of tons. The data may also shed more light on the nature of gamma ray bursts—erratic pulses of gamma rays that appear every month or so and flash across the solar system. Their origin is a mystery.

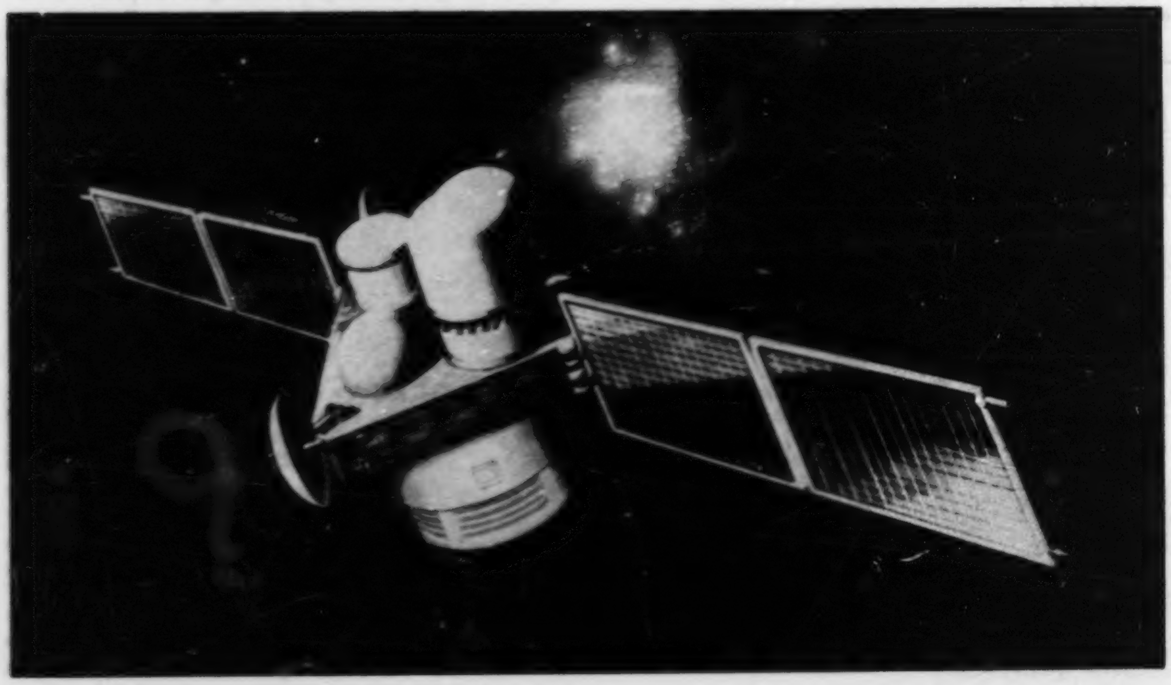
Like X-rays, gamma rays are a form of electromagnetic radiation (as is ordinary light), but they have extremely high energy and correspondingly short wavelengths (less than 10^{-11} centimeters). At maximum strength, a gamma ray unit packs several million times as much energy as a comparable unit of visible light.

Unlike X-rays, however, which are typically emitted by hot gas, gamma rays are believed to come from the core of the phenomenon, produced by special nuclear processes. Gamma ray astronomy allows scientists to investigate these special processes.

Until recently all astronomy observations were of atoms, ions and molecules, and their emissions. Gamma rays were recognized after World War II as an important aspect of space research, but work in this field was slow. A long program of balloon research proved rather disappointing, with only hints that gamma ray sources were being detected.

Then a small experiment on an Orbiting Solar Observatory detected the first certain gamma rays. This gave scientists the confidence to launch in 1972 the Small Astronomy Satellite 2 with a small detector for very high energy gamma rays. This spacecraft, along with the European spacecraft COS-B (1975), and the first High Energy Astronomy Observatory, provided the basic data which will be exploited by the more powerful Gamma Ray Observatory.

The observatory will be managed by Goddard Space Flight Center and the satellite will be carried into a planned orbit of 400 to 500 kilometers by the Space Shuttle.



Tile Repair Kit for Shuttle

A Space Shuttle on-orbit thermal tile repair kit is now under development for NASA. The kit is designed for use by Shuttle crews to repair possible damage to any of the thousands of ceramic-based tiles which cover the orbiter and protect it from intense heat during reentry into the Earth's atmosphere. The kit will not be flown on the first test flight but will be held in reserve for possible use on later flights where the launch environment will approach design conditions.

A letter contract signed by NASA and Martin Marietta Aerospace, Denver Division, is preliminary to an official contract award and authorizes the aerospace manufacturer to proceed with immediate design and development of the tile repair kit. Estimated value of the contracts is $2.1 million.

The letter contract followed studies conducted by four aerospace companies for the NASA Johnson Space Center, Houston. Proposals were received from General Electric Co., Philadelphia, and Martin Marietta Aerospace. The contract calls for Martin to design and fabricate three repair kits for delivery to NASA by September. Two of the units are for flight use and the third is for astronaut training.

A space-suited astronaut would don a backpack maneuvering unit in the Shuttle cargo bay, inspect the outside of the orbiter, and if necessary, use the kit to apply ablative repair materials.

NASA to Buy Spacelab From ESA

The National Aeronautics and Space Administration has signed a $183,960,000 contract calling for manufacture and delivery in 1984 of a second Spacelab by the European Space Agency.

The first Spacelab, a reusable spaceborne scientific laboratory, already is being designed and built by ESA for delivery in time to be aboard an early operational flight of the U.S. Space Shuttle.

Funding for development of the Spacelab concept and manufacture of the first flight unit is provided by ESA member nations and is estimated to exceed $850 million.

In return for the contribution of the first flight unit, NASA agreed to procure from the European agency a second flight unit and others if needed in the future.

The second Spacelab, like the first, will be built by the ERNO industrial facility in Bremen, Germany, prime contractor to the European Space Agency.

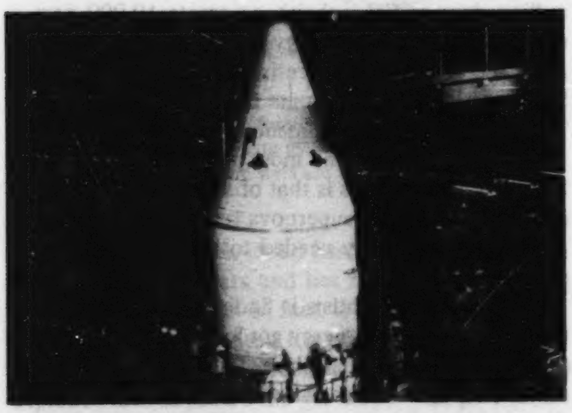
At least 26 subcontractors, in the European Space Agency member nations of Germany, France, Italy, United Kingdom, Spain, Belgium, The Netherlands, Switzerland, Austria and Denmark, as well as in the United States, are expected to be involved in producing components and subassemblies of the second Spacelab.

Spacelab is to be a major element of the NASA Space Transportation System being developed to transport people and material economically and

Aviation Tackles Tile Factor—Providing an example of NASA program interdependence, an F-15 research aircraft is shown flight testing the Space Shuttle's thermal protection tiles over California. In tests conducted by the Dryden center, the tiles on the F-15's right wing (dark section) are simulating the leading edge of the Shuttle Orbiter's wing. The tile sections will eventually be submitted to almost one and one-half the dynamic pressure that the Shuttle will attain during launch. Further testing will involve both the F-15 and F-104 aircraft, as part of the overall verification of the various Shuttle systems.

routinely between the ground and Earth orbit. Spacelab will be transported aboard the Space Shuttle for Earth-orbital missions lasting 7 to 30 days. It will remain attached to the orbiter throughout each mission. Spacelab will have facilities and equipment similar to laboratories on Earth but adapted for zero gravity.

Study in Concentration—Members of the Orbiter Integrated Test team are intent on their monitors during the recent Kennedy Space Center simulated flight. The team is made up of some 120 engineers and technicians from both NASA and aerospace contractors and they monitor progress of the critical operational test in the Launch Control Center's Firing Room 1. The group is comparable in size to the launch team that will be used on early Shuttle missions.



Topping Off the Left Booster—The launch of the Space Shuttle comes a step closer at the Kennedy center with the mating of the left Solid Rocket Booster (SRB) forward assembly, consisting of nose cap, frustum and forward skirt. Topping off the left Solid Booster is an integral part of the "stacking" process and the complete SRB assembly is scheduled for rollout in April. Both Twin Boosters produce some six million pounds of thrust at liftoff.

Solar Maximum Mission

In the second launch of the new year, a four-meter-long spacecraft carrying a wide range of scientific instruments was sent into orbit from the Kennedy Space Center aboard a Delta rocket. The date was Feb. 14. A NASA Fact Sheet explained the mission:

A major step toward understanding the violent nature of the Sun and its possible effects on Earth is the promise of the Solar Maximum Mission.

Solar flares are expected to occur most frequently near the maximum of the Sun's 11-year cycle expected in 1980–81. The flares are a complex phenomenon and no two are exactly alike.

The Solar Maximum Mission will use a variety of observation methods, including satellites, sounding rockets and ground-based instruments, to study solar flares through their individual life histories.

The mission's satellite is designed to provide scientists with observations of solar flares (violent eruptions on the Sun's surface) over a wide band of wavelengths in the ultraviolet, X-ray and gamma ray regions of the electromagnetic spectrum. Through coordinated observations at many different wavelengths, scientists expect to obtain many clues about the causes of solar flares and how they might be predicted.

Although the spacecraft will concentrate on solar flare activity, instruments are expected to measure also the Sun's radiation to within one-tenth of one percent of the total output over a period of one year. According to computer model predictions of the response of Earth's atmosphere to solar radiation, such a precise measurement should be sufficient to definitely establish whether changes in total solar heat output are sufficient to affect climate and weather.

The satellite will operate in a 574 kilometer-high circular orbit with a planned incline 28.6 degree to the Equator. Solar Maximum takes 96 minutes to complete an orbit. At the end of its mission, the satellite may be retrieved by the Space Shuttle.

U.S., China Agree on Landsat Station

NASA and the Chinese Academy of Sciences signed a Memorandum of Understanding Jan. 24 covering China's participation in the experimental Landsat program. China will establish a ground station in the Beijing area to read out Earth resources data from Landsat D.

The ground station is to be purchased from U.S.

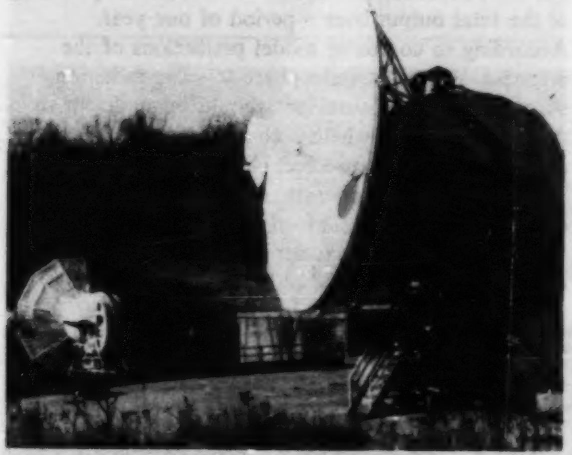
industry under the Understanding on Cooperation in Space Technology of Jan. 31, 1979. The Landsat Memorandum of Understanding is the first formal agreement in the space area since the normalization of U.S.-China relations.

The signing came during a visit to China by a delegation headed by Dr. Frank Press, Presidential Science Advisor, which included NASA Administrator, Dr. Robert A. Frosch.

The agreement, which parallels those signed with a number of other foreign ground station operators, provides that the Chinese Academy of Sciences will make Landsat data it receives openly and uniformly available to others on a basis similar to the distribution policies followed by NASA and other U.S. agencies. The Academy will help share in the cost of operating the Landsat satellites by paying an annual access fee of $200,000, beginning six months after the Beijing station begins receiving data.

Six Landsat ground stations already are in operation outside the U.S.: two in Canada and one each in Brazil, Italy, Sweden and Japan. New ground stations in Australia and India now are receiving test data and soon will be operational. Another station is under construction in Argentina, while a number of others are in the planning stages elsewhere.

U.S. ground stations for Landsat are located at Fairbanks, Alaska; Goldstone, Calif.; and at the NASA Goddard Space Flight Center, Greenbelt, Md.



Satellite Antenna Slated for China—A tracking station for the Landsat Earth resources satellite, similar to this one at the NASA/Goddard center in Greenbelt, Md., will be built in mainland China under a recent agreement. The Chinese ground antenna is expected to incorporate even more sophisticated equipment than the Greenbelt facility, which receives signals from Landsat's Return Beam Vidicon Cameras and Multi-Spectral Scanner.

Landsat D is expected to be operational in 1982. Landsat 3, launched in March 1978, still is operating. Landsat data are being used by scientists and local officials in the U.S. and more than 100 foreign countries for a wide variety of applications ranging from crop inventories to flood assessment and mineral exploration. The Beijing ground station is expected to make significant contributions to Chinese modernization in such areas as agriculture, forestry and mining.

Space Superbubble Light Years Away

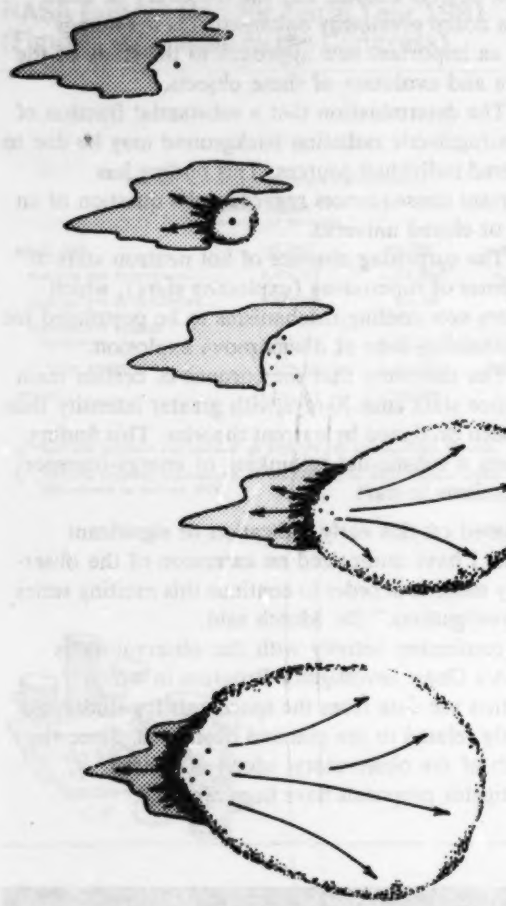
A superhot, superbubble of gas, apparently confined to a gigantic, glowing ring or shell some 6,000 light years away from Earth and some 1,200 light years in diameter, has been discovered, centered in the prominent summer constellation Cygnus, the Northern Cross.

The discovery was made from satellite data by Dr. Webster Cash, Laboratory for Atmospheric and Space Physics at the University of Colorado, Boulder, and his co-investigator, Dr. Philip Charles, Space Science Laboratory, University of California, Berkeley. They used X-ray data from NASA's Earth-orbiting High Energy Astronomy Observatory 1.

Dr. Cash reported the sphere contains enough superheated gas at 2 million degrees Celsius (3.5 million degrees Fahrenheit), to create 10,000 new stars like our Sun. Its energy output is equal to 10 times the amount of the entire energy emitted by our Sun since its formation some five billion years ago. There is no known phenomenon in the galaxy with that kind of energy. The most powerful explosion known to astronomers is that of a supernova, an exploding star, but a supernova releases only about 3 percent of the energy needed to make the superbubble.

What puzzles scientists is finding an answer to how this huge amount of energy got locked up in this gigantic halo in the first place. Dr. Cash thinks there may have been a series of explosions of supernovas in the region over the past three million years, perhaps anywhere from 30 to 100 which, in sequence, together created the superheated superbubble.

Here's how it may have happened according to Dr. Cash: A huge cool gas cloud, measuring 800 by 3,000 light years, known as the Great Rift of Cygnus can be seen obscuring the Milky Way in Cygnus on a



Evolution of Superbubble—Schematic shows, top to bottom, the five steps in an evolutionary process that took eons. First, cloud and star; star becomes supernova and shock wave strikes cloud; new stars are formed from cloud; new stars become supernovas and create the bubble, which starts to inflate; and finally, as more stars are formed, the superbubble grows even larger.

dark night. This dark cloud has enough material to make five million stars and lies right next to the observed superbubble. In fact, it obscures the central part of the bubble as seen from Earth.

About three million years ago a supernova exploded and impacted the gas cloud with part of the star blowing into interstellar space. As the force of the explosion moved through the cloud, the compression caused the gas to coalesce about 100,000 years later, forming a group of perhaps 1,000 stars of which number about 10 would become supernovas. Supernova stars have a lifetime of only about one million years.

These 10 stars would explode, in turn, pushing the gas cloud back farther and causing more stars to form along its edge as the compression on the cloud continued. At the same time, the force of the explosions away from the cloud caused a sweeping effect on interstellar space making a shell or bubble of superheated hydrogen material that became the immense superheated, superbubble we see in X-ray data today.

Dr. Cash said these chains of star formation are a major mechanism for making new stars. "The Sun may well have been formed at the edge of a similar bubble," he said. The reason the huge halo was never spotted before is because, Dr. Cash says, "it flows so energetically that it cools through emission of X-rays instead of more normal emissions that can be seen in the optical or infrared regions of the spectrum." The hotter a substance is, the shorter its radiation wave length.

Although parts of it had been seen before in brief X-ray glimpses, no one knew what was being observed. One part, for example, was thought to be a supernova remnant, while another part was believed to be hot gas escaping from the galaxy.

Because of its large size, the bubble or halo, was not seen in its entirety until it could be picked up in the X-ray sweep provided first by the High Energy Astronomy Observatory launched in August 1977. The spacecraft burned up as it reentered the Earth's atmosphere last March after accomplishing its mission.

The observatory was built by TRW Systems, Redondo Beach, Calif. The High Energy Observatory Project management is under the direction of NASA's Marshall Space Flight Center. The cosmic X-ray experiment instrument from which the data were made available to the two scientists was built under the direction of Dr. Elihu Boldt, NASA Goddard Space Flight Center, and Dr. Gordon Garmire, California Institute of Technology, Pasadena.

HEAO 2 to Keep Working

High Energy Astronomy Observatory 2, originally scheduled to end operations after one year in Earth orbit, will continue to search the skies for information about such objects as quasars, pulsars, exploding galaxies and black holes. NASA officials decided that the many significant findings attributed to HEAO 2—which carries the largest X-ray telescope every built—warranted an extension of its space science

HEAO 2 before encapsulation in its payload shroud.

mission beyond the projected lifetime of 11 months. The satellite is popularly known as the Einstein Observatory.

"The performance of the observatory has been excellent throughout the first year of the mission," said Dr. Thomas A. Mutch, NASA Associate Administrator for Space Science. "The operation of the scientific instruments has met or exceeded our expectations."

The instruments continue to operate satisfactorily. A solid state spectrometer, which performed exceptionally well, has depleted its cryogens, and ceased operating, as expected.

Among the most significant new findings from the observatory are the following:

- The X-ray observation of more than 60 known quasars, ranging from relatively nearby to the most distant objects known, and the discovery of more than a dozen previously unknown. These findings open an important new approach to the study of the nature and evolution of these objects.
- The determination that a substantial fraction of the extragalactic radiation background may be due to scattered individual sources. This finding has important consequences regarding the question of an open or closed universe.
- The surprising absence of hot neutron stars at the center of supernovas (exploding stars), which requires new cooling mechanisms to be postulated for the remaining core of a supernova explosion.
- The discovery that the coronas of certain main sequence stars emit X-rays with greater intensity than had been predicted by current theories. This finding requires a substantial rethinking of energy-transport mechanisms in stars.

"Based on this early indication of significant results, I have authorized an extension of the observatory mission in order to continue this exciting series of investigations," Dr. Mutch said.

A continuing activity with the observatory is NASA's Guest Investigator Program in which scientists use data from the spacecraft for studies not directly related to the planned objectives. Since the launch of the observatory, about 400 guest investigator proposals have been received.

Agency Cited for Civil Service Reform—Singular honor came to NASA in January as Deputy Administrator Dr. Alan M. Lovelace accepted the first Udall-Derwinski Award for Civil Service Reform from Rep. Morris K. Udall, D-Ariz. (center) and Rep. Edward J. Derwinski, R-Ill. The National Aeronautics and Space Administration was recognized for initiative, excellence and leadership in its conversion to the Senior Executive Service. The awards ceremony, citing individuals and agencies for their efforts in implementing the Civil Service Reform Act of 1978, was held at the Department of State.

NASA Budget Plan for Fiscal Year 1981 (Figures submitted to the Congress)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BUDGET SUMMARY
(Thousands of Dollars)

BUDGET PLAN	FY 1979	FY 1980	FY 1981
Research and development.....	3,477,200	4,107,500a/	4,569,500
Construction of facilities...	347,500	156,100	120,000
Research and program management..................	933,800	1,006,186b/	1,047,134
TOTAL BUDGET PLAN.........	4,758,500	5,269,786	5,736,634
OUTLAYS.......................	4,196,472	5,012,600	5,439,700

a/ Includes proposed supplemental of $300,000,000 for the Space Shuttle.

b/ Includes proposed supplemental of $46,286,000 to cover revised salary rates implemented in October 1979.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT PROGRAMS

BUDGET PLAN
(Thousands of Dollars)

Cognizant Office and Program	FY 1979	FY 1980	FY 1981
SPACE TRANSPORTATION SYSTEMS	2,011,600	2,403,300	2,738,200
Space Shuttle............................	1,638,300	1,886,000a/	1,873,000
Space flight operations................	299,700	446,600	809,500
Expendable launch vehicles............	73,600	70,700	55,700
SPACE SCIENCE	505,400	600,800	668,000
Physics and astronomy..................	282,900	337,100	438,700
Planetary exploration..................	182,400	219,900	179,600
Life sciences............................	40,100	43,800	49,700
SPACE AND TERRESTRIAL APPLICATIONS	283,900	343,900	394,800
Space applications......................	274,800	331,800	381,700
Technology utilization..................	9,100	12,100	13,100
AERONAUTICS AND SPACE TECHNOLOGY	376,400	427,100	409,500
Aeronautical research and technology..	264,100	308,300	290,300
Space research and technology.........	107,300	115,800	115,200
Energy technology.......................	5,000	3,000	4,000
SPACE TRACKING AND DATA SYSTEMS	299,900	332,400	359,000
TOTAL.................................	3,477,200	4,107,500	4,569,500

a/ Includes proposed supplemental of $300,000,000 for the Space Shuttle.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE TRANSPORTATION SYSTEMS

BUDGET PLAN
(Thousands of Dollars)

	FY 1979	FY 1980	FY 1981
SPACE SHUTTLE	1,638,300	1,886,000a/	1,873,000
Design, development, test and evaluation..............................	(1,270,300)	(1,030,500)	(683,000)
Orbiter................................	727,800	560,900	320,900
Main engine............................	172,700	140,600	145,700
External tanks.........................	104,800	79,400	48,000
Solid rocket boosters..................	115,400	61,200	14,000
Launch and landing.....................	149,600	188,400	154,400
Changes/systems upgrading..............	(---)	(100,000)	(150,000)
Production..............................	(368,000)	(755,500)	(1,040,000)
Orbiter................................	264,500	572,600	768,200
Main engine............................	75,500	123,600	121,500
Launch and landing.....................	7,000	16,400	40,400
Spares and equipment...................	21,000	42,900	109,900
SPACE FLIGHT OPERATIONS	299,700	446,600	809,500
Space transportation system operations capability development...............	64,500	54,100	89,000
Spacelab................................	26,700	38,800	151,700
Space transportation system operations.	24,300	148,100	374,300
Development, test and mission support..	177,200	172,600	183,300
Advanced programs.......................	7,000	13,000	10,800
EXPENDABLE LAUNCH VEHICLES	73,600	70,700	55,700
Scout....................................	10,600	5,100	2,200
Centaur..................................	17,300	18,300	5,600
Delta....................................	45,700	46,100	47,900
Atlas-F..................................	---	1,200	---
TOTAL SPACE TRANSPORTATION SYSTEMS...	2,011,600	2,403,300	2,738,200

a/ Includes proposed supplemental of $300,000,000.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SCIENCE

BUDGET PLAN
(Thousands of Dollars)

	FY 1979	FY 1980	FY 1981
PHYSICS AND ASTRONOMY	282,900	337,100	438,700
High energy astronomy observatories development..............................	10,647	2,100	---
Solar maximum mission development......	16,700	3,100	---
Space telescope development............	79,300	112,700	119,300
International solar polar mission development..............................	12,300	47,900	82,600
Gamma ray observatory development......	---	---	19,100
Shuttle/Spacelab payload development and mission management................	34,900	40,900	72,100
Explorer development....................	31,288	32,300	33,000
Mission operations and data analysis...	25,453	37,100	38,900
Research and analysis...................	44,005	34,100	42,800
Suborbital programs.....................	28,207	26,900	30,900
PLANETARY EXPLORATION	182,400	219,900	179,600
Galileo development.....................	78,700	116,100	63,100
Mission operations and data analysis...	59,300	58,800	64,800
Research and analysis...................	44,400	45,000	51,700
LIFE SCIENCES	40,100	43,800	49,700
Life sciences flight experiments.......	15,700	16,600	19,200
Research and analysis...................	24,400	27,200	30,500
TOTAL SPACE SCIENCE..................	505,400	600,800	668,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE AND TERRESTRIAL APPLICATIONS

BUDGET PLAN
(Thousands of Dollars)

	FY 1979	FY 1980	FY 1981
SPACE APPLICATIONS	276,800	321,800	381,700
RESOURCE OBSERVATIONS	139,400	145,203	162,300
Landsat-D	97,500	98,663	64,300
Operational land observing system	---	---	16,000
Magnetic field satellite	3,900	1,600	500
AgRISTARS	---	16,000	33,200
Shuttle/Spacelab payload development	6,200	1,850	2,000
Applied research and data analysis and related activities	30,800	27,090	46,300
Completed projects	1,000	---	---
ENVIRONMENTAL OBSERVATIONS	67,750	109,470	137,600
Earth radiation budget experiment	7,000	17,000	29,000
Halogen occulation experiment	3,600	8,000	6,000
National oceanic satellite system	---	---	5,800
Shuttle/Spacelab payload development	7,750	9,600	8,200
Advanced research and data analysis and related activities	41,076	74,370	88,600
Completed projects	8,324	500	---
APPLICATIONS SYSTEMS	15,950	14,547	18,100
TECHNOLOGY TRANSFER	10,700	10,087	12,500
MATERIALS PROCESSING IN SPACE	20,400	19,768	22,200
Space processing applications rocket project	3,600	2,100	---
Shuttle/Spacelab payload development	11,950	11,218	10,500
Applied research and data analysis	4,850	6,450	11,700
SPACE COMMUNICATIONS	22,600	22,725	29,000
Search and rescue	8,000	5,000	2,300
Shuttle/Spacelab payload development	1,200	1,660	---
Applied research and data analysis and related activities	13,400	16,065	26,700
TECHNOLOGY UTILIZATION	9,100	12,100	13,100
TOTAL SPACE AND TERRESTRIAL APPLICATIONS	285,900	333,900	394,800

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AERONAUTICS AND SPACE TECHNOLOGY

BUDGET PLAN
(Thousands of Dollars)

	FY 1979	FY 1980	FY 1981
AERONAUTICAL RESEARCH AND TECHNOLOGY	264,100	308,300	290,300
Research and technology base	109,700	119,000	131,100
Systems technology programs	154,400	189,300	159,200
(Aircraft energy efficiency technology included in systems technology)	(97,400)	(116,100)	(65,000)
SPACE RESEARCH AND TECHNOLOGY	107,300	115,800	115,200
Research and technology base	86,277	99,785	103,400
Systems technology programs	12,023	11,015	9,700
Standards and practices	9,000	5,000	2,100
ENERGY TECHNOLOGY	5,000	3,000	4,000
TOTAL AERONAUTICS AND SPACE TECHNOLOGY	376,400	427,100	409,500

SPACE TRACKING AND DATA SYSTEMS

	FY 1979	FY 1980	FY 1981
TRACKING AND DATA ACQUISITION	299,900	332,400	359,000
Operations	249,903	264,500	271,500
Systems implementation	40,497	57,300	76,200
Advanced systems	9,500	10,600	11,300

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 CONSTRUCTION OF FACILITIES PROGRAM

BUDGET PLAN
(Thousands of Dollars)

PROJECTS BY INSTALLATION

Ames Research Center	13,180
Construction of Man-Vehicle Systems Research Facility	7,480
Modification of Steam Ejector System and Thermal Protection Laboratory (N-234)	2,300
Modification of the Unitary Plan Wind Tunnel (N-227)	3,400
Jet Propulsion Laboratory	3,500
Modifications to Various Buildings for Energy Conservation	1,500
Modifications to Various Buildings for Seismic Protection	2,000
John F. Kennedy Space Center	760
Rehabilitation of High Temperature Hot Water System, Zone 2, Industrial Area	760
Langley Research Center	22,756
Modifications for Avionics Integration Research Laboratory (1220)	5,756
Modifications to Aircraft Landing Dynamics Facility (1257)	15,000
Rehabilitation and Modification of Gas Dynamics Laboratory (1247)	2,000
Lewis Research Center	12,355
Decommissioning of Plum Brook Station Reactor Facility	3,000
Modifications to Central Air System, Various Buildings	7,655
Rehabilitation of Electrical Switchgear, Engine Research Building 5	1,700
Michoud Assembly Facility	4,582
Rehabilitation of Roof, Phase II, Building 103	3,800
Rehabilitation of Chilled Water System	782
Various Locations	2,130
Modification of 26-Meter Antenna, DSS-44, Canberra, Australia (JPL)	1,200
Replacement of Azimuth Radial Bearing, DSS-14, Goldstone, CA (JPL)	930
Space Shuttle Facilities at Various Locations as Follows:	10,300
Modification of Manufacturing and Final Assembly Facilities for External Tanks (MAF)	5,600
Modifications to Solid Rocket Motor Manufacturing and Assembly Facilities, Thiokol Plant, Wasatch, Utah	2,700
Minor Shuttle-Unique Projects (Various Locations)	2,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 CONSTRUCTION OF FACILITIES PROGRAM

BUDGET PLAN
(Thousands of Dollars)

PROJECTS BY INSTALLATION

Space Shuttle Payload Facilities at Various Locations as Follows:	1,617
Rehabilitation and Modification for Payload Ground Support Operations (KSC)	1,617
Repair of Facilities at Various Locations, Not in Excess of $500,000 per Project	15,000
Rehabilitation and Modification of Facilities at Various Locations, Not in Excess of $500,000 per Project	20,000
Minor Construction of New Facilities and Additions to Existing Facilities at Various Locations, Not in Excess of $250,000 per Project	4,000
Facility Planning and Design	10,000
TOTAL	120,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND PROGRAM MANAGEMENT

BUDGET PLAN
(Thousands of Dollars)

INSTALLATION	FY 1979	FY 1980	FY 1981
Johnson Space Center	152,930	162,881	170,688
Kennedy Space Center	123,314	131,861	161,385
Marshall Space Flight Center	149,007	157,599	160,377
National Space Technology Laboratories	4,488	4,899	5,108
Goddard Space Flight Center	127,910	135,805	139,335
Wallops Flight Center	15,806	17,085	18,977
Ames Research Center	62,712	69,801	71,469
Dryden Flight Research Center	19,068	21,702	21,681
Langley Research Center	106,643	116,060	119,145
Lewis Research Center	87,457	97,825	101,360
NASA Headquarters	84,473	90,688	97,629
TOTAL	933,808	1,006,186[a]	1,067,154

[a] Includes proposed supplemental of $46,286,000 to cover revised salary rates implemented in October 1979.

TOTAL NUMBER OF PERMANENT POSITIONS - END OF YEAR

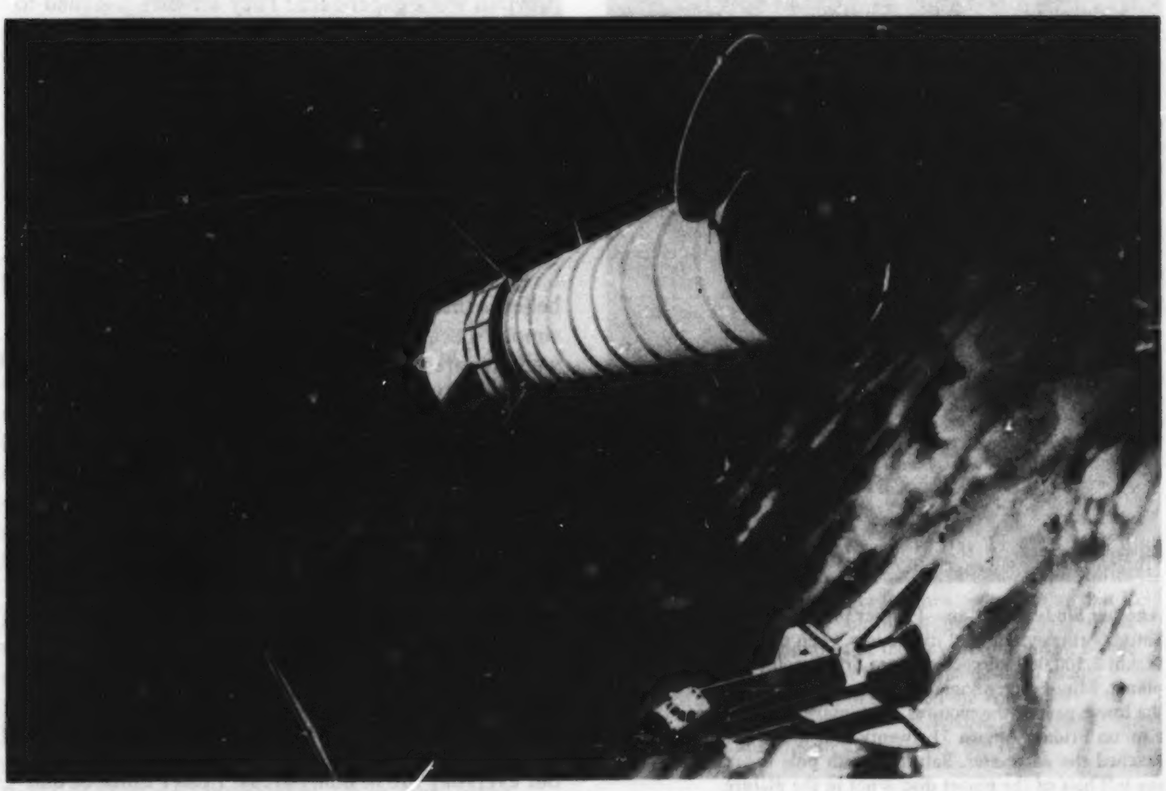
Johnson Space Center	3,504	3,469	3,494
Kennedy Space Center	2,193	2,191	2,201
Marshall Space Flight Center	3,636	3,561	3,561
National Space Technology Laboratories	104	103	103
Goddard Space Flight Center	3,482	3,440	3,440
Wallops Flight Center	398	395	395
Ames Research Center	1,666	1,658	1,658
Dryden Flight Research Center	480	461	461
Langley Research Center	3,005	2,980	2,980
Lewis Research Center	2,858	2,835	2,835
NASA Headquarters	1,505	1,520	1,585
TOTAL	22,831	22,613	22,713

Search for Space Telescope Facility

Proposals for the establishment of a Space Telescope Science Institute facility in the United States were due by March 3 at Goddard Space Flight Center, Greenbelt, Md. The Institute will be a national facility for the receipt and evaluation of data from the 9,100-kilogram Space Telescope and is scheduled to be fully operational in the early 1980s.

Located on a site to be chosen by the contractor, the Science Institute will be responsible for selection and support of observers to use the telescope, for detailed science planning and scheduling, routine console operations, data archiving, calibration and analysis.

The contractor will staff the facility with scientists to manage the various science programs and perform related astronomical research. In addition, all personnel and facilities necessary to house and support principal investigators and general observers are to be provided. In addition, the winning contractor will staff and operate the Space Telescope Science Support Center (science control center) at Goddard.



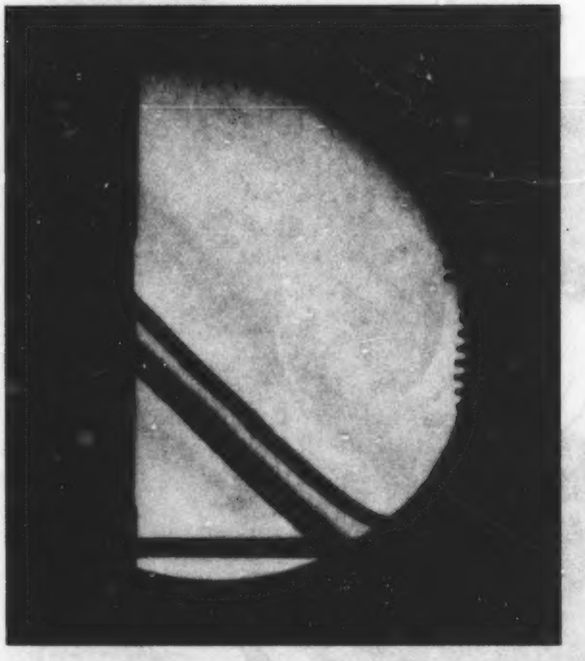
Artist's concept of the 2.4 meter Space Telescope after leaving the Shuttle Orbiter.

The 2.4-meter Space Telescope is scheduled to be placed in a 500-kilometer orbit inclined 28.8 degrees to the equator by the Space Shuttle in late 1983 or early 1984. Circling the Earth above the obscuring atmosphere, the telescope will observe some 350 times more volume of space than can be seen now from ground-based observatories.

Science and spacecraft data will be transmitted via a Tracking and Data Relay Satellite to the control center at Goddard and then sent on to the Science Institute for processing and analysis.

The telescope is expected to function at least until the end of the century. At about 30-month intervals, the Space Shuttle will visit the telescope in orbit where astronauts will perform maintenance and replace scientific instrumentation.

NASA's Marshall Space Flight Center is the project manager for the Space Telescope, and Goddard is responsible for management of the onboard science instrumentation and the Space Telescope Science Institute.



Another Study of Saturn—Further pictures by Pioneer show Saturn's ring system and its shadow when the spacecraft was within 1,500,000 kilometers from first encounter with the planet. Minor data anomalies appear as a dark band across the lower part of the pictures. The image was made at 7:32 a.m. on Friday, August 31, twenty four hours before Pioneer reached the encounter. Saturn's north pole is at 2 o'clock and the left half of the planet disc is not in the picture.

19-Year-Old NASA Flight Controller

When the manned Space Shuttle makes its first Earth orbital flight later this year, the flight data will be monitored closely by space flight controllers, including 19-year-old Jackie Parker. Jackie works in the data processing system at Johnson Space Center in Houston.

Being the agency's youngest flight controller could be trying, but it doesn't seem to rattle Ms. Parker. She's used to being the youngest. When she was only 13 years old, she was accepted at a North Carolina college. She was a college freshman at 14.

"My interests all along were in math, and flying and computer sciences," she said in a recent interview. "By the time I got to college and I realized that harder, more challenging things were very realistic for me, that's when I decided to go to work for NASA and to go further with my own interests."

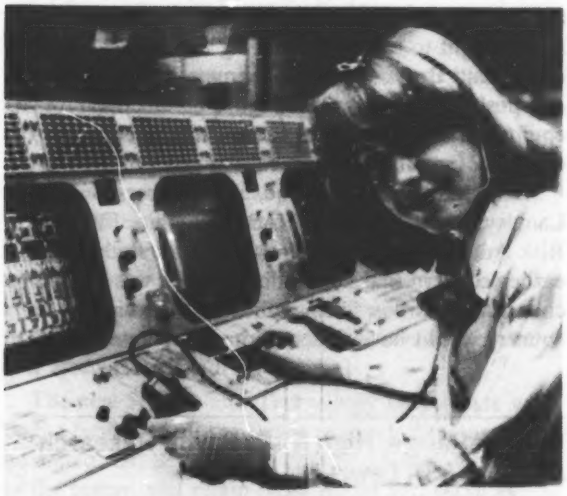
The training is the hardest part of her job. It is a never-ending process, according to Jackie. Flight controllers are always learning, always studying. In selecting flight controllers, NASA looks for people with a technical background, either in education or in previous work experience. They are then assigned to work directly with a senior flight controller, learning the special peculiarities of the Mission Control Center and developing the capabilities and techniques necessary to the job.

Pete Frank, Chief of the Flight Control Division at Johnson says a good flight controller must have two main characteristics—technical expertise and the ability to apply that knowledge to actual operations.

The training is so detailed and thorough that Jackie believes the Space Shuttle mission will be relatively simple "because I think by that time, we will be very well prepared and we will have learned and built up confidence in our team."

What about the future? Where does a 19-year-old NASA flight controller look for her next challenge? Why, to space, of course. Jackie plans to be an astronaut. She believes that someday journeys into space will become routine and sees the conquest of space as part of humanity's eternal search for knowledge. "When we try to devise new technologies . . . we end up discovering many other things along the way. Now we have hundreds and hundreds of spinoffs from the past space programs and in the process of building the new Space Shuttle we have come across many other spinoffs that affect our everyday life in many areas. I can't think of one area that NASA has not contributed to, and I don't think people are aware of that. And that's why I think the space program is important. It's not just exploring space . . . it is helping us live more comfortably, sustaining life longer and finding new resources."

In the meantime, Jackie Parker intends to continue trying to be the best flight controller she can be and an important part of NASA's next manned step in space.



Jackie Parker at her console in Houston.

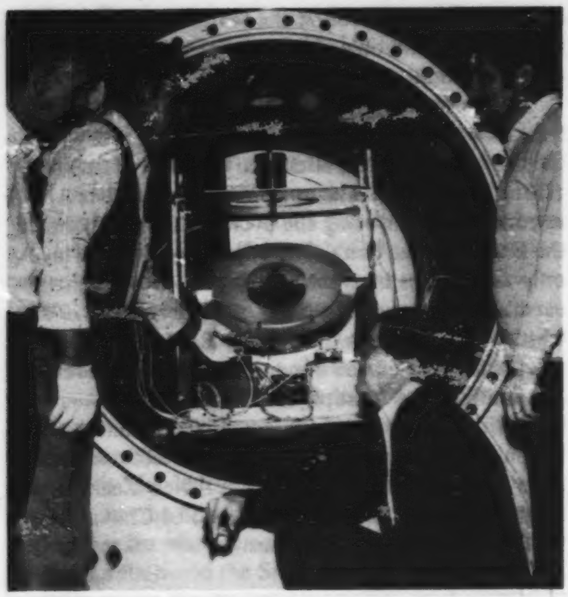
Possible Astronomical Missing Link Found

California Institute of Technology planetary scientists have discovered an object orbiting the sun that may be the missing link between the class of asteroids that cross the orbit of Earth, and comets. It has been suggested by some scientists that many small asteroids that come close to the Earth are the remains of comets that have exhausted their volatile materials, which give them their characteristic diffuse heads—or comas—and tails.

The object was discovered by planetary scientist Eleanor F. Helin, assisted by Schelte Bus of Caltech, who have been engaged in a search for planet-crossing asteroids with Caltech Professor of Geology Eugene M. Shoemaker. The object was first detected in November 1979 on photographic plates taken with the 18-inch Schmidt Telescope at Hale Observatories' Palomar Moutain Observatory. Since then, other observations from around the world have been used to determine the object's orbit and physical characteristics.

The object, designated as 1979VA, orbits the Sun about every 4½ years, passing from just within the orbit of the Earth, almost to the orbit of Jupiter (from .98 to about 4½ astronomical units, one astronomical unit being the average distance between the Earth and the Sun). The object's orbit is inclined only 2.8 degrees from the ecliptic, the plane of the earth's orbit around the Sun. At discovery, 1979VA was about 13 million miles from Earth. Orbital calculations have been done by Brian G. Marsden of the Smithsonian Astrophysical Observatory, Cambridge, Mass., and Dr. James G. Williams of Jet Propulsion Laboratory. More than 20 observations from telescopes in the U.S., France, New Zealand, England, and the People's Republic of China were used in Marsden's calculations.

Prize for Jupiter Prognosis—Ray Reynolds, left, and Patrick Cassen, research scientists at Ames Research Center, pose with a picture of volcanoes erupting on Jupiter's moon, Io. In a NASA-Ames study, the two joined Stanton J. Peale, University of California, Santa Barbara, in predicting that Io had a molten interior and volcanic eruptions. Their scientific paper predated photographs of the Io eruptions taken by the Voyager spacecraft as it flew past the planet-sized moon. The three-man team has been awarded the American Association for the Advancement of Science-Newcomb-Cleveland prize for the prescient report.



Dynamics Explorer Experiment—Scientists and engineers at Marshall Space Flight Center's Space Science Lab examine a Retarding Ion Mass Spectrometer upon completion of its calibration tests in a vacuum chamber. The instrument will fly aboard the Dynamics Explorer satellite in 1981 to investigate the coupling of energy and particles between Earth's atmosphere, magnetosphere and ionosphere. Left to right are John Reynolds, Roy Hunt, Dr. C. R. Chappell (principal investigator) and Stanley Fields (lead engineer for SSL).

Risk "Insignificant' With Carbon Fiber

A 22-month U.S. government/industry study has determined that the risk of electrical equipment damage from release of carbon fibers from a civil aircraft accident is insignificant.

Results from the NASA analysis were reported at a conference at Langley Research Center where representatives of several government agencies and private companies presented technical papers and oral reports on various aspects of continuing government study of the potential use of carbon fibers.

R. R. Heldenfels, Langley's Director for Structures, summarized the NASA study results by saying the public risk from using carbon fibers on current and future civil aircraft in the United States is so small as to be insignificant.

Carbon or graphite fibers are small-diameter filaments used to make composite materials. Composites are formed when fibers are embedded in a plastic matrix to form a solid material. Composites are being used increasingly in aircraft because of their high strength, durability, improved performance factors and lighter weight.

Composites are also used in many commercial products, from recreation to industrial equipment. With a growing demand for composites, the government became concerned about potential accidential release of the fibers. The perceived potential risk stems from the reaction of most composite structures to burning, which causes the composites to break down, releasing short lengths of fibers into the atmosphere. Considered to be highly heat-resistant and electrically conductive, the released fibers were first thought to be very damaging to electrical equipment. Because of their extreme lightness, fibers can possibly float for miles, settle on electrical equipment and sometimes cause short circuits or equipment malfunctions.

"The study had to be done," says Robert Huston of Langley, Manager of the NASA Graphite Fibers Risk Analysis portion of the goverment study. "If the earlier concern had materialized, there was a good chance that carbon fiber applications throughout the country would have been seriously impacted."

Longer-Range, High Risk/Payoff Research Aim of NASA Lewis

A realignment of functions and capabilities to emphasize its current major research and technology roles in aeronautics, space and energy was announced in January by the NASA Lewis Research Center.

Lead center for NASA in energy conversion technology, Lewis said that all R&T (research and technology) programs are being regrouped under aeronautics, space and energy and that a fourth directorate—Science and Technology—is being established to facilitate longer-range, high risk/high payoff research.

Under the restructuring, Dr. John F. McCarthy, Jr., Lewis director, said Lewis would maintain and improve leadership as a premiere energy conversion laboratory.

"Ours will be a posture most responsive to the challenges of the future," he said.

"We will be able to better utilize our in-house skills in a true across-the-board matrix fashion so that new technology that advances aeronautical propulsion can, for example, be readily considered for application to terrestrial energy projects," he explained. "By the same token, we will be better able to bring the advantages of space technology innovation to aeropropulsion and terrestrial energy needs of the nation."

Among current Lewis objectives in terrestrial energy, he listed efforts to bring wind energy systems to a competitive status costwise with fossil-fuel generating systems throughout the country; to further the use and improve the economics of solar cell (photovoltaic) energy systems as a supplementary or prime source of electric power in remote areas; and to advance the technology of alternative automobile engines and propulsion systems that would greatly conserve fuel, reduce pollution and have multi-fuel capability. All of this work, he said, is being managed by Lewis for the Department of Energy.

Among current aeronautical propulsion objectives, Dr. McCarthy cited programs underway aimed at developing more fuel-efficient, cleaner-burning and lower-polluting engines for aircraft of the mid-eighties and beyond. Aeronautical propulsion still represents approximately 40 percent of the center's work mix. More noteworthy space projects at Lewis coming under the new organization matrix would be the recently enlarged Lewis thrust in space communications and continuing strong participation in chemical and electric rocket development.

The new Science and Technology Directorate will be the largest of all the Lewis research directorates, he added. Dr. Seymour C. Himmel, associate director of the center, will retain those duties and serve as acting head of the new directorate.

Said Dr. Himmel:

"A number of advantages accrue to combining our generic disciplines in one management grouping. Concentration will be fixed on basics. It has become more and more evident that advances in technologies such as materials, structural mechanics, aerodynamics, acoustics, fuels and combustion, fluid and thermal processes, measurement, controls and electronics are not only critical to Lewis objectives but are relied upon by our country for its economic well being and and security.

"Also, a single management will serve as a focal point for the emergence and development of new ideas. It will emphasize the type of inhouse exploratory and innovative research in which Lewis has always excelled."

Previously, the Lewis organization format emphasized projects and programs with individual research and technology support. The realignment lays greater stress on technological innovation and makes such technological innovation more accessible to every project office.

Contractor News

Detroit Diesel Allison of Indianapolis, a division of General Motors Corp., has been awarded a $65 million Federal contract for its automotive industry team to develop an advanced gas turbine engine for autos as an alternative to the spark-ignition (internal combustion) engine. The award was negotiated by NASA's Lewis Research Center, which managed several parts of the Department of Energy's Automotive Development program. The contract is cost-shared with no-fee and Detroit Diesel's cost share is $5.2 million.

The Boeing Company and Johnson Space Center have extended for 18 months their cost-plus-award fee contract for safety, reliability and quality assurance engineering support. The extension brings the total value of the Boeing contract to over $36 million.

McDonnell Douglas Astronautics Co., of Huntington Beach, Calif., has received a letter contract from the Goddard Space Flight Center for fabrication and subassembly of vehicles for Delta launches 164 and 165; another letter contract from Goddard to McDonnell Douglas calls for long lead-time materials for Delta launch vehicles 166 through 170. Both are add-ons to existing fixed price contracts, the former in the amount of $2 million and the latter over $1 million. The work is to be performed at Huntington Beach and subcontractor facilities.

Woman Astronaut 'Weightless'—Dr. Shannon Lucid, a mission specialist astronaut, uses a power tool on the Space Telescope mockup in the Marshall Space Flight Center's Neutral Buoyancy Simulator, as part of a project for servicing the telescope in Earth orbit. Dr. Lucid, of the Johnson Space Center, recently became the first woman astronaut to work in the simulator. (Distortion caused by the curvature of the plastic helmet makes the astronaut's head appear smaller than actual.)

Patents for Inventions from NASA Research

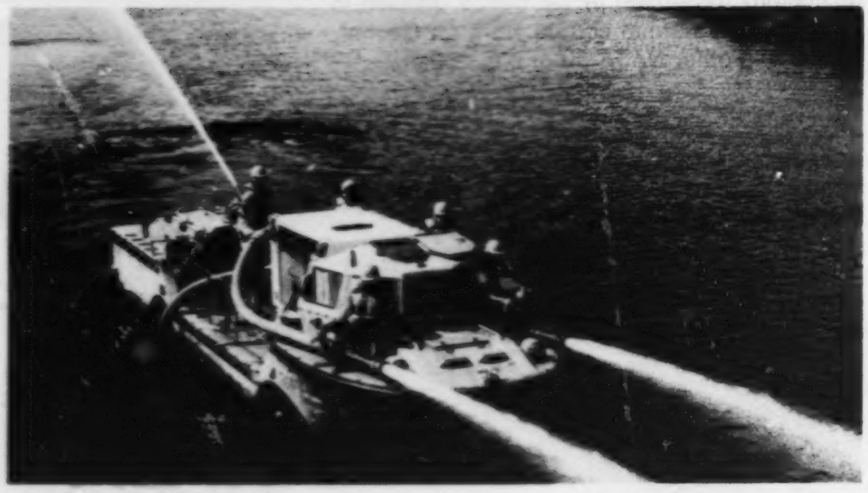
The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Rudolf A. Schindler Caltech/JPL, Pasadena, Ca.	Over-under double pass interferometer	4,181,440	NRO/JPL
Donald E. Brooks, Univ. of Oregon, Portland, Or.	A method for separating biological cells	4,181,589	MESC
Jack E. Cornett Ralph C. Corley Thomas O. Fraley Andrew A. Saunders, Jr. General Electric Co. Cincinnati, OH.	Method and apparatus for rapid thrust increases in a turbofan engine	4,184,327	LeRC
John W. Vorreiter NASA/Ames Research Center Moffett Field, Ca.	Cryogenic container compound suspension strap	4,184,609	ARC
Paul B. Reese, David W. Murphy Rockwell International Space Systems Group Downey, Ca.	A pressure limiting propellant actuating system	4,183,217	MSC
Paul M. Sawko, Salvatore R. Riccitiello, Charles L. Hammermesh Rockwell International 1,000 Oaks, Ca.	Ambient cure polyimide foams	4,184,021	ARC
Gary B. Turner, Caltech/JPL Pasadena, Ca.	Solar cell I-V curve driver	4,184,111	NPO
John F. Holmes, Ronald T. Miles Computer Sciences Corp. Applied Technology Division, Falls Church, Va.	Charge injection method and apparatus of producing large area electrets	4,184,368	MFS
Merle A. Economu, Gerald J. Baker, NASA/Dryden	Air speed and attitude probe	4,184,149	FRC
John S. J. Benedicto, Bruce E. Woodgate, NASA/Goddard	Method and apparatus for slicing crystals	4,184,472	GSC
William J. McGannon NASA/Lewis	Intra-ocular pressure normalization technique and equipment	4,184,491	LeRC
Paul A. Dillard, Walter M. Fritz Dan R. Lott, Lockheed Electronics Co., Sunnyvale, Ca.	Method of fabricating a photovoltaic module of a substantially transparent construction	4,184,903	NPO
Stephen R. Peck, Jeffrey W. Benham, General Electric Co. Philadelphia, Pa.	Voltage feed through apparatus having reduced partial discharge	4,185,164	GSC
Wilford E. Siverston, Jr. NASA/Langley	Radar target for remotely sensing hydrological phenomena	4,184,155	LaRC
Maynard C. Sanford, David L. Gray NASA/Langley	Solar cell angular position transducer	4,184,072	LaRC
Randolf R. Culotta, Donald L. Posey, NASA/Langley	Static pressure orifice system testing method and apparatus	4,182,158	LaRC
Milton H. Brockman, Mahlon F. Easterling, (Caltech) JPL/Pasadena, Ca.	Radio frequency arraying	4,186,347	JPL

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January 17	Atlas Centaur	ETR	DOD Navy. Reimbursable
SMM-A	February 14	Delta	ETR	NASA. Scientific Solar Maximum Mission.
NOAA-B	May	Atlas-F	WTR	NOAA Weather. Reimbursable.
Navy-20	July	Scout	WTR	DOD Transit. Reimbursable.
GOES-D	August	Delta	ETR	NOAA Weather. Reimbursable.
Intelsat V-A	September	Atlas Centaur	ETR	Intelsat communications. Reimbursable.
Navy-21	October	Scout	ETR	DOD Transit. Reimbursable.
SBS-A	October	Delta	ETR	Satellite business systems. Reimbursable.
FLTSATCOM-D	November	Atlas Centaur	ETR	DOD Navy. Reimbursable.
Intelsat V-B	December	Atlas Centaur	ETR	Intelsat communications. Reimbursable.

Oblique Wing in Flight—Dryden center cameras capture the AD-1 Oblique Wing Research Aircraft over the dry lakebed at Edwards, Calif. NASA Dryden civilian pilot Tom McMurtry is at the controls. The small, light-weight research plane is testing a pivoting-wing concept which may reduce noise and lower fuel consumption in future high-speed, transport type aircraft.



Amphibious Firefighter Tested—Members of the City of Miami Fire Department are shown using a lightweight firefighting module that evolved from pumps developed by the Marshall Flight Center for rocket motors. The unit is being tested aboard an amphibious vehicle obtained through government surplus. Miami firefighters say the configuration can be driven along the shoreline and into the canal and can pump up to 2,000 gallons of water per minute. The module was provided by Aviation Power Supply, in cooperation with NASA.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Alaska Pipeline Insulation

Crude oil moving through the 800-mile Trans-Alaska Pipeline must be kept at a relatively high temperature—about 180 degrees Fahrenheit—to maintain the fluidity of the oil. In Arctic weather, that demands highly effective insulation. General Electric Co.'s Space Division, Valley Forge, Pennsylvania, provided it with a spinoff product called Therm-O-Trol. Shown being installed on the pipeline, Therm-O-Trol is a metal-bonded polyurethane foam especially formulated for Arctic insulation.

A second GE spinoff product, Therm-O-Case, solved a related problem involved in bringing hot crude oil from 2,000-foot-deep wells to the surface without transferring oil heat to the surrounding permafrost soil; heat transfer could melt the frozen terrain and cause dislocations that might destroy expensive well casings. Therm-O-Case is a double-walled oil well casing with multi-layered insulation which provides an effective barrier to heat transfer. Therm-O-Trol and Therm-O-Case* are members of a family of insulating products which stemmed from technology developed by GE Space Division in heat transfer/thermal control work on Gemini, Apollo and other NASA programs.

For the benefit of all . . .

NASA
National Aeronautics and
Space Administration

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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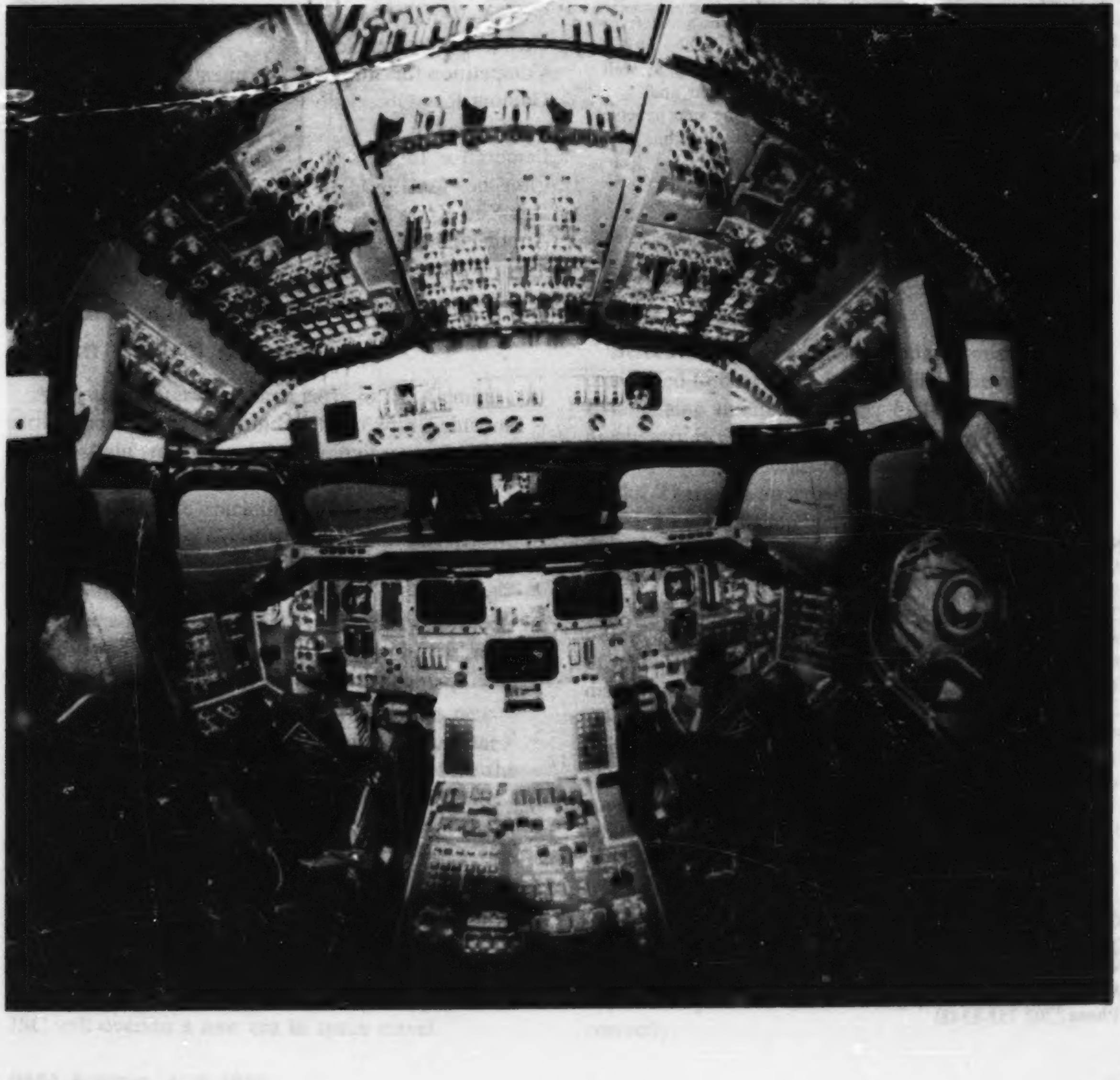

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COVER

Columbia's Flight Deck—The Space Shuttle commander sits in the traditional left seat with the pilot on the right. For the flight test program, the orbiter is equipped with ejection seats. In the event escape becomes necessary, the overhead panels are designed to eject before the seats blast out. (The curved view of the cockpit was provided by a special "Fish Eye" lens).

In front of each astronaut is a rotational hand controller, used to actually fly the spacecraft. The controller provides information to the computer system which then records attitude changes. The commander has a translation controller for moving the craft along any axis in flight.

Between the commander and pilot are the flight computer and navigation aid console. Immediately in front of the console are the three cathode ray tubes (CRT) used to display computer information for the crew. To the right and left of the CRTs are standard flight instruments such as the altitude direction indicator and horizontal situation indicator as well as air speed and direction finders. Communications and electrical equipment controls are located on the side panels with the overhead panels holding environmental, lighting and some electrical instrumentation and controls.

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Mission Control Gearing Up

At historic intervals, since early in the Gemini series, the cavernous room has filled with sights and sound—light from the array of monitors and projection screens, voices in the calm monotone of controllers and the crackling transmission of far-away astronauts. Mission Control in Houston has held the attention of the world, from Gemini and the Apollo lunar landings to the 171 days of Skylab manned operation and the US-Soviet Apollo Soyuz project. In the hours of tension and days of triumph, the room became a place unique to all human endeavor.

Now, Mission Control is preparing for its new adventure, to be the focal point for Earth-orbital flights through this decade and beyond. Before the year is out, personnel at the Johnson Space Center expect to control the initial orbital mission of the Space Shuttle.

Because the Space Shuttle, as workhorse of the space transportation program, will carry communications satellites, weather satellites and scientific experiments into space on a regular basis, return to Earth and later reenter orbit with another payload, JSC will oversee a new era in space travel.

Before the actual launch, simulated missions are conducted to check out each detail of the equipment. Establishing an effective interplay between people and machinery is the most difficult of all problems in developing a spacecraft operational system that works. There are approximately 75 controllers working each of the eight-hour shifts in the Mission Control Center to make certain the flight operations work perfectly in all aspects and at all times.

The controllers work in teams—each with a different function. The flight control team is composed of technical representatives from the many technical disciplines. These staffers monitor the whole variety of spacecraft subsystems, including life support, thermal control, propulsion, navigation, flight operations, communications, and vehicle systems. There are specialists who work on trajectory patterns, those who work with experiments and those who direct NASA's worldwide tracking network.

Each controller constantly monitors the telemetry from the spacecraft, evaluating the performance of the system which is his or her responsibility, verifying that it is working properly and observing the crew's use of the system to make certain it is responding correctly.

The simulated tests are as close to the real action as one can get. Pete Frank, Chief of the Flight Control Division at Johnson, said: "... it can get so realistic that there are times when you actually forget you are simulating. You become so involved and so wrapped up in the simulation that sometimes it feels like it's the real mission."

There are three phases to the simulations: launch, orbit and reentry. During the countdown, the Houston Mission Control Center simply monitors. The launch control center at Kennedy Space Center in Florida is responsible for the countdown and getting the spacecraft to a liftoff condition. Once launched, Houston Mission Control takes over.

"The level of activity here is quite high," said Frank. "A lot of things are happening; a lot of different events occur; and we are monitoring those to verify that the vehicle is working correctly."

During the reentry phase, it is Mission Control's main goal to see that the spacecraft guides itself through the difficult reentry phase and that the vehicle is performing as expected. If it is not performing well, Frank said, it is their responsibility to come up with the best technique for solving the problem.

Frank said Mission Control is not yet ready for the flight, but "we will be ready when we are needed. We will be there when the vehicle is."

Orbiter integrated test team functioning in Firing Room 1.

Orbiter Integrated Tests Complete

A major step leading toward the first launch of the Space Shuttle was taken in January with the successful completion of an extensive orbiter integrated test series.

The test series involved the simulation of five launches, more than two days of on-orbit operations and two mock reentry and landing profiles. It marked the first time that all ground and flight hardware was linked together and tested exactly as it would be used for actual space missions.

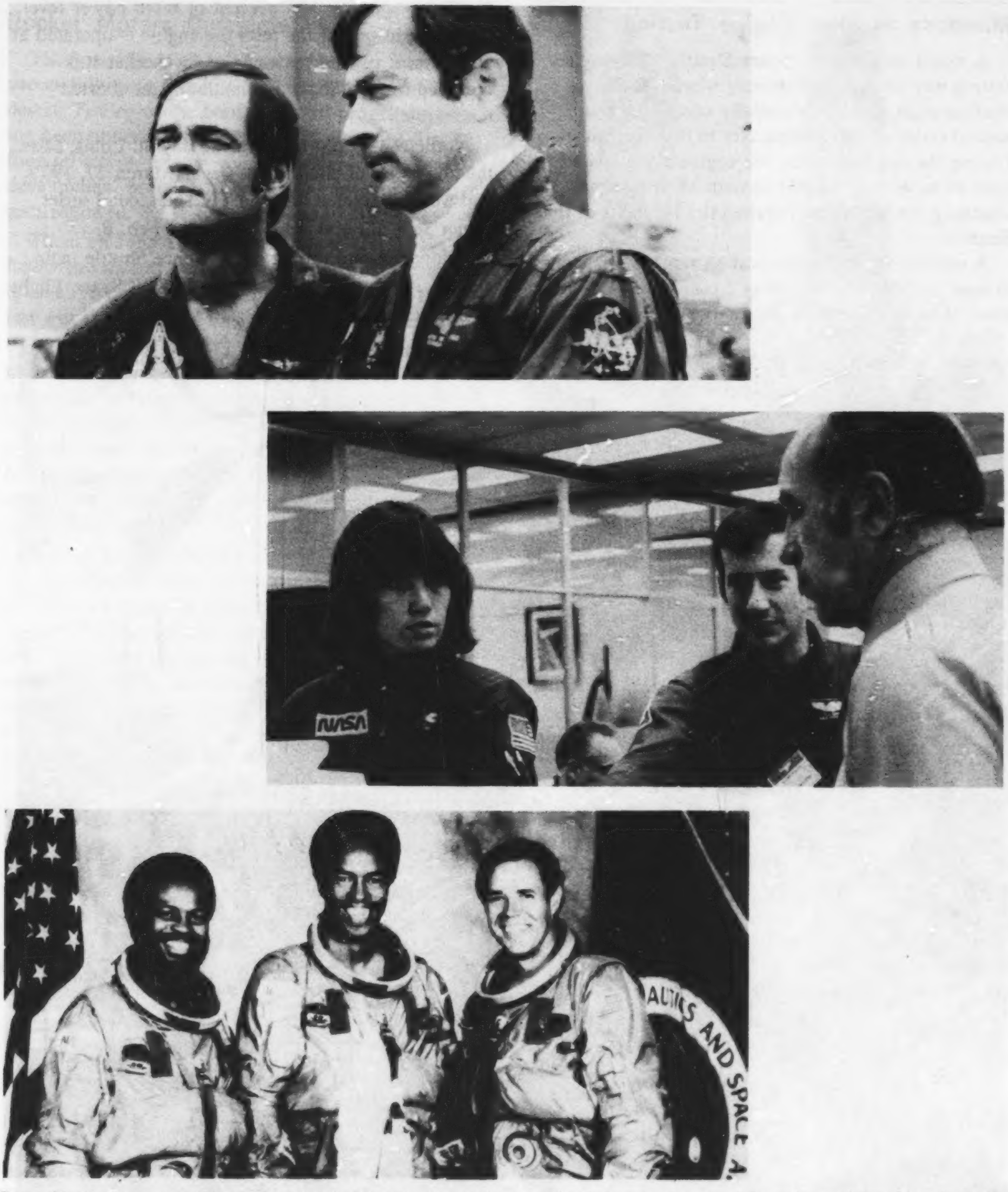
Involved in the tests were teams of nine different astronauts and all ground personnel who will conduct the actual launches of the shuttle. Primary flight crew for the first Space Shuttle flight, astronauts John Young and Robert Crippen performed much of the simulated launch missions, a large portion of the orbital practice and both of the descent runs. Other astronauts in the series were Joe Engle and Richard Truly, backup crew for the first shuttle flight to take place later this year. Providing invaluable assistance and gaining precious experience in the series were support astronauts Karol Bobko, Loren Shriver, Dick Scobee, Fred Gregory and newly assigned Ellison Onizuka.

Although designed to take only five days, the series ran for nearly two weeks due to numerous minor difficulties. The majority of these were attributable to software problems, difficulties with complex simulation gear and other equipment which will not be used for actual flight.

The objective of the test series was to test the union of flight and ground computer equipment, and this went very well. George Page, director of Shuttle Operations said, "With the tests we have completed so far, we are pleased with how compatible the orbiter flight hardware is with our launch processing system and ground support equipment."

In addition, many orbital maneuvers needed during space flight were simulated. Delicate maneuvering of the shuttle with the various control systems and deployment of the cargo bay doors and shuttle radiators were among the orbital tasks as well as more mundane checks of food heating oven, fuel cell operations and life support equipment.

The successful completion of the tests clears the way for future assembly with the external tank and solid rocket motors, although much work and more tests remain.



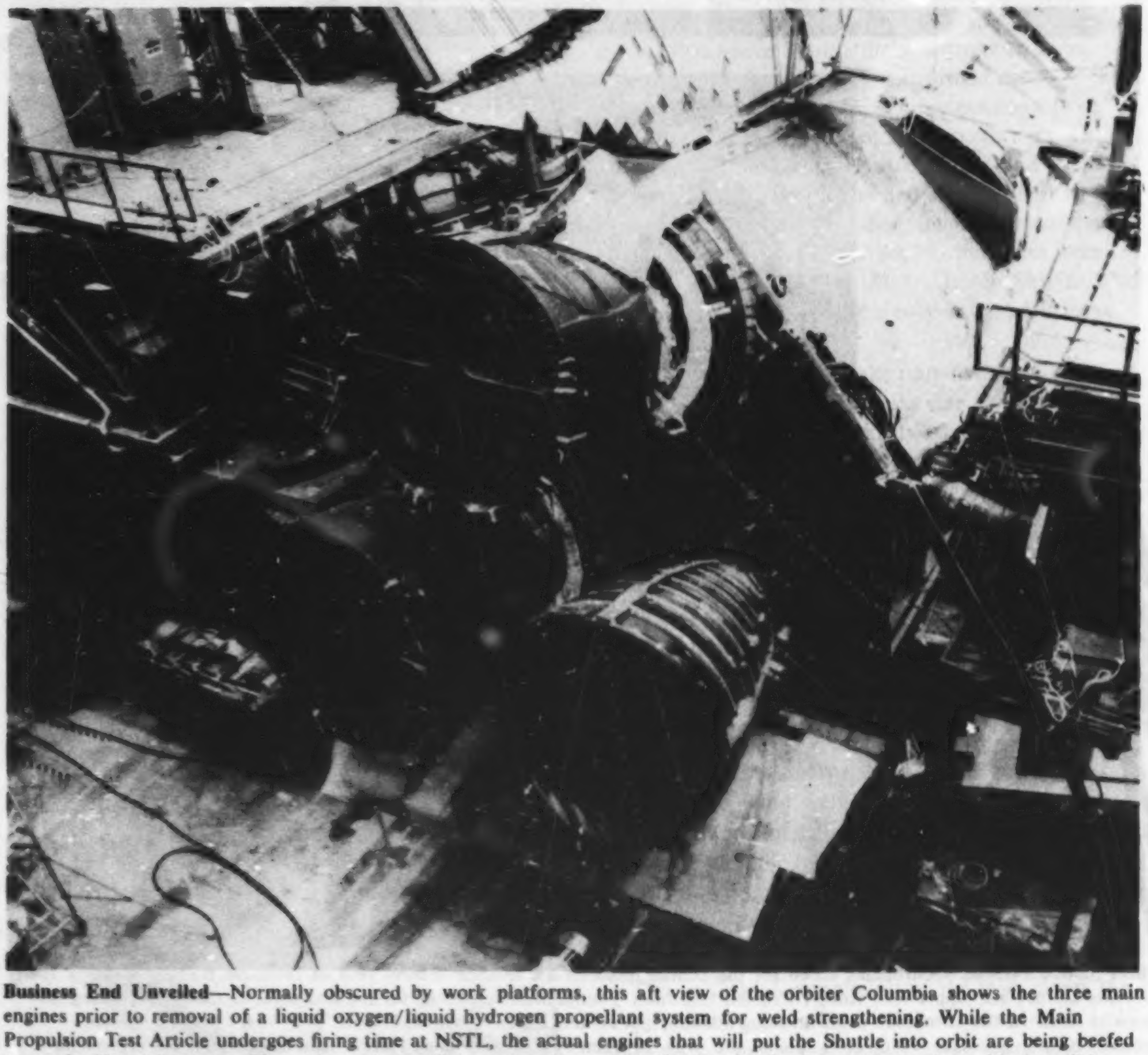
Space Shuttle Persona—Astronauts slated for the Shuttle missions are in their second year of intensive training. Seen in their working clothes are (upper left) Robert Crippen and John Young, prime crewmen for the first flight of Columbia, facing the press at KSC. At the Grumman plant on Long Island (right center) Anna Fisher, M.D., one of NASA's first six woman astronauts, and colleague Terry Hart discuss the work restraint system with Gene Harms, lead engineer on the project. In a formal portrait at JSC (lower left) black astronauts model the modified USAF high altitude pressure suit for ejection escape. They are, left to right, Dr. Ronald E. McNair, Maj. Guion S. Bluford, and Maj. Frederick D. Gregory.

Milestone in Main Engine Testing

A major milestone in Space Shuttle main engine testing was reached in February when a flight configuration engine successfully completed the second series of tests preliminary to flight certification. During the two test series, the engine accumulated a total of more than 10,000 seconds of firing time, equalling the firing time required for 19 flights of the Shuttle.

A preliminary flight certification test series includes at least 13 firings for a total of 5,000 seconds of firing time. Most of the tests in each series are conducted for 520 seconds at 100 percent of rated power level. However, in one of the tests the engine is operated at 102 percent of rated power and in another it is operated for 823 seconds, simulating an aborted mission.

At the NASA test facility near Bay St. Louis, Miss., the first series of engine tests began March 27, 1979, and were completed on June 27. The second series began Sept. 22 and were completed Feb. 8. Development and testing of the Space Shuttle main engines is managed by NASA's Marshall Space Flight Center, Huntsville, Ala.



Business End Unveiled—Normally obscured by work platforms, this aft view of the orbiter Columbia shows the three main engines prior to removal of a liquid oxygen/liquid hydrogen propellant system for weld strengthening. While the Main Propulsion Test Article undergoes firing time at NSTL, the actual engines that will put the Shuttle into orbit are being beefed up at the Kennedy center. The main engines will burn for about eight minutes after launch and in tandem with the solid rocket boosters, for the first two minutes of flight.

Rocket Motors Complete Firing

The Space Shuttle's solid rocket booster motor successfully completed its final test firing in the Utah desert. Testing of the booster's solid propellant motor has been underway since July 1977 when the first of four prototype motors was static fired for development purposes. Three more developmental tests followed, the last one on Feb. 17, 1979.

Then, on June 13, 1979, a series of test firings of flight-type motors was initiated to qualify the motors for manned flight. The Wednesday, Feb. 13, 1980, test was the third and final firing in that series.

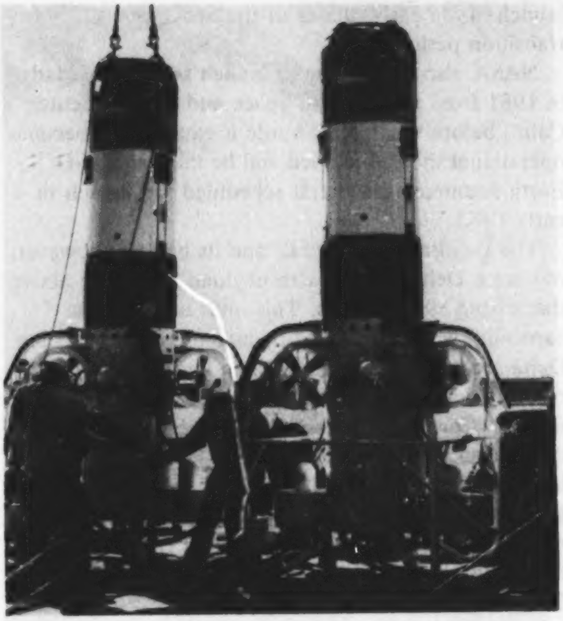
All seven tests in both the development and qualification program were described as highly successful by booster development managers at Marshall Space Flight Center. "With the completion of these tests," said Robert E. Lindstrom, manager of Marshall's Shuttle Projects Office, "we can be confident that the solid rocket motors will perform successfully in flight."

Two of the large solid rocket boosters, of which the motor is the major component, will provide much of the Space Shuttle's thrust for liftoff from the launch pad and during the first two minutes of flight. After their propellant has burned out, the boosters will separate from the Shuttle's fuel tank and parachute into the ocean where they will be recovered and returned to Kennedy Space Center for refurbishment in Utah and reuse on subsequent missions.

The assembled motor is more than 35 meters long and 3.5 m in diameter, and reaches a peak thrust of about 12 million newtons. It is the largest rocket motor of its type ever developed for space flight and the first built to be used for launching manned spacecraft. Motors for the boosters were developed and tested by the Wasatch Division (Brigham City, Utah) of Thiokol Corp., under contract to the Marshall center.

Delta Launches To Continue

NASA is prepared to maintain an expendable launch vehicle capability at the Eastern Space and Missile Center, Fla., as a backup to the Space Shuttle through the transition to full Space Transportation System operations. In doing so, the Agency will use the standard 3910 version of the Delta launch vehicle, which can place spacecraft of up to 1,100 kilograms into a geosynchronous transfer orbit. Commercial users of the Deltas will be charged $22 million per



Water Testing Booster Gear—Technicians from the Kennedy center recently conducted maneuvering tests with nozzle plugs for the solid rocket boosters in Port Canaveral waters. The 14-foot nozzle plugs will be used to help recovery of the boosters after each Space Shuttle launch and they are remotely controlled through umbilical cables from the recovery ship. Each plug will facilitate inflation and dewatering so that the booster will float on the surface horizontally for towing to port, there to be refurbished for subsequent reuse.

launch in the early phases of the Space Shuttle transition period.

NASA also is planning to launch several payloads in 1981 from the Western Space and Missile Center, Calif., before the Space Shuttle is expected to become operational there. Included will be the Landsat-D Earth resources spacecraft scheduled for launch in early 1982.

The Landsat-D spacecraft and its backup, however, require a Delta vehicle with payload capability above that of the 3910 version. This increase in Delta capability will be achieved by augmenting an existing Delta second stage engine with an improved injector recently developed for the Air Force by Aerojet General Corp., and by using larger second stage fuel tanks, also available from Aerojet. Uprated Delta launchers, to be called Delta 3920, will have a payload capability up to 1,250 kg for a geosynchronous transfer orbit. The development cost of uprating the Delta second stage is estimated at from $7.5 to $9 million. The vehicle hardware cost per launch will be about $2.5 to $3 million more than that of the standard Delta 3910.

Last October, potential commercial users were asked if they would be interested in sharing the $7.5–9 million development cost of the uprated vehicle. This offer was aimed primarily at commercial users with large geosynchronous orbiting communications spacecraft who are already scheduled on early Space Shuttle operational flights, but who might want a backup launch alternative in the event flight schedule changes or delays affect Space Shuttle operations.

Telesat of Canada agreed to fund about 20 percent of the costs, with NASA paying the remainder. If other commercial users decide to reserve a backup Delta 3920, they will be charged a share of the total development costs while the Telesat and NASA share will be reduced proportionately.

A fixed-price incentive contract will be negotiated with the Delta prime contractor, McDonnell Douglas Astronautics Co., Huntington Beach, Calif., for procurement of Delta model 3920.

The Delta launch vehicle is managed for NASA's Office of Space Transportation Operations by the NASA Goddard Space Flight Center. The Kennedy Space Center in Florida is responsible for launch operations management.

Delta Does the Expected—In a panoramic view of the KSC launch complex, beyond the museum of missiles past, the remarkable Delta rocket carries its 151st payload to orbit: the Solar Maximum Mission. Delta has been designated the backup launch vehicle until the Space Transportation System is fully operational. The Delta saga of success began in 1960.

Large Wind Turbines Pending

Under a Department of Energy-sponsored program, NASA has selected the Boeing Co. and General Electric Co. for contract negotiations to design, construct, install and test advanced multimegawatt wind turbine systems. If the development program meets its goals and if the machines are produced in quantity, they could generate electricity at costs comparable with conventional energy sources.

Boeing Engineering & Construction Co., Seattle, and General Electric's Aerospace Group, Valley Forge, Pa., were named to develop and build an advanced large wind energy system for use in moderately windy areas of the country. NASA is negotiating contracts for about $15–20 million each for the 4-megawatt (4000 kilowatt) wind-turbine systems with blades 91 meters or more from tip to tip.

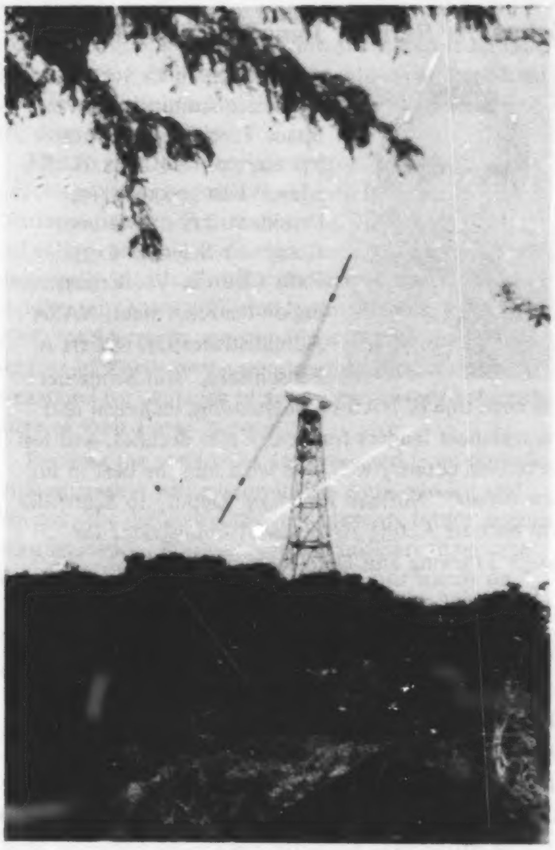
The wind turbines will be designed for sites with an annual mean wind speed of 23 kilometers per hour. Sites with such modest winds are relatively common throughout the United States. The wind turbines are scheduled to be built in late 1983 at sites to be selected by the Department of Energy. The project will be directed by NASA's Lewis Research Center in Cleveland.

The test systems, located at utility company sites, will supply electricity to the local electrical system for use by the general public. The purpose is to evaluate the economics and to test operating characteristics of advanced large wind turbines coupled to conventional electric utility systems.

The experimental wind turbine (the name for modern electricity generating windmills) is part of the Department of Energy's program to develop wind energy systems as a supplementary energy source for the nation. NASA Lewis, with expertise in aerodynamics and structures, directs the portion of the wind energy program concerned with large utility-size systems.

Presently, Lewis is operating for the Department of Energy a 100-kw, 38-m wind test bed built at the Lewis Plum Brook test area near Sandusky, Ohio. This machine is being used to test advanced components and systems which have the potential for increasing the performance and reliability of large wind turbines.

Three 200-kw versions of the 38-m system are in operation at utility sites in Clayton, N.M.; Block Island, R.I.; and Culebra, Puerto Rico. A fourth machine is being built by Westinghouse for installation on the Hawaiian Electric System this spring.



Wind Turbine Program Expanding—This turbine generator, dedicated in 1978 on Culebra Island, Puerto Rico, will be improved upon under a pending NASA agreement with the Boeing Company and GE. The companies have been selected to build larger and more advanced windmill machines as part of a DoE-sponsored program.

A 2,000-kw, 61-m diameter machine developed by General Electric for the two federal agencies is presently being tested and supplying power on the Blue Ridge Electric Cooperative System in Boone, N.C.; and a 2,500-kw, 91-m diameter experimental machine is being developed for them by Boeing Engineering & Construction. Three of these machines will be installed in the first wind turbine cluster at Goodnoe Hills, Wash., in the Bonneville Power System in late 1980 and 1981.

The Department of Energy also is investigating and developing small (2 to 40 kw) windmills that could be used by individual rural homes or farms, and is performing research and development on advanced unconventional wind energy systems.

Schneider Retires, Joins Private Industry

Dr. William C. Schneider, Associate Administrator for Space Tracking and Data Systems, retired from NASA March 1 to become Vice President, Systems Group, Computer Sciences Corp., Falls Church, Va. Commenting on the retirement, NASA Administrator Dr. Robert A. Frosch said, "Bill Schneider has been one of NASA's outstanding technical and management leaders for nearly two decades, and has served his country well. We wish him the best in his new career." Norman Pozinsky, Deputy to Schneider, will become Acting Associate Administrator for Space Tracking and Data Systems.

Schneider joined NASA in June 1963 and became Deputy Director of the Gemini Program in November 1963. Later he served as Mission Director for seven of the 10 manned Gemini missions and was Mission Director for Apollo missions 4 through 8. From December 1968 until July 1974 he was Director of NASA's Skylab Program, later serving as Deputy Associate Administrator for Space Transportation Systems from 1974 until 1978 when he became Associate Administrator for Space Tracking and Data Systems.

Schneider received the NASA Exceptional Service Medal for his work in Gemini, the NASA Distinguished Service Medal for directing the Apollo 8 mission which was the first manned lunar orbit mission and a second Distinguished Service Medal for directing the Skylab Program. His leadership of Skylab also resulted in his receiving the Robert J. Collier Trophy for 1973 along with the three Skylab astronaut crews. He is an Associate Fellow of the American Institute of Aeronautics and Astronautics and a Fellow of the American Astronautical Society.

A native of New York City, he received a bachelor of science degree in aeronautics from the Massachusetts Institute of Technology in 1949, a master of science degree from the University of Virginia in 1952 and a doctorate of engineering from Catholic University, Washington, D.C., in 1976.

On leaving NASA, Dr. Schneider said, "I have always been lucky to have had the best job in the best project in the best agency. But my real good fortune was knowing and working with the competent, dedicated, fine group of men and women—the NASA team."

Commercial Combine in Space

The first step in a new and innovative program to stimulate the commercialization of space was taken when NASA and the McDonnell Douglas Astronautics Co., St. Louis, Mo., signed a joint endeavor agreement to develop a new technique in materials processing in space.

Under the agreement, McDonnell Douglas and a major pharmaceutical firm will conduct a research and development program to determine the feasibility of separating biological materials in space using a process known as continuous-flow electrophoresis. This process has a high probability of producing substances useful in the diagnosis, treatment, or prevention of human or animal diseases. These substances are currently not being produced in sufficient quantities or purity in ground-based facilities.

This joint endeavor agreement is the first of its kind and represents a new concept NASA has developed to involve the private sector in the definitive stages of a space research program where a technological advancement is needed and there is a potential commercial application. In a joint endeavor, NASA and a private firm agree to be responsible for specific portions of the research effort and no funds are transferred between parties.

Upon signing the agreement, Erwin F. Branahl, Vice President/General Manager of McDonnell Douglas Astronautics Co., said: "This agreement will enable private industry to begin the long and difficult task of developing processes that take advantage of the unique environment of space, of finding new ways to develop products that may profoundly affect our daily lives. It is an ambitious program, but one in which we have a great deal of faith."

Dr. Robert A. Frosch, NASA Administrator, cited such joint endeavors as fulfilling the need "to broaden the base of understanding the materials processing in space technology particularly with regard to its usefulness in the private sector where economic benefits may result."

NASA On Ice—At the bottom of the world stands Dr. Everett Gibson of Houston and the Johnson Space Center. Member of an Antarctic field trip, Gibson has packed his gear aboard a snowmobile on Rose Island and is setting out in search of meteorites. In the background are two islands, about 16 kilometers away. The flags are the United States, NASA and Texas.

Meteorites Assist Search For Life

A NASA meteorite sample program is providing basic clues to a University of Maryland researcher in the quest for the origins of life and organic matter in our universe. Dr. Cyril Ponnamperuma, director of the Laboratory of Chemical Evolution at the university's College Park, Md. campus, led a team of scientists which recently discovered amino acids—the basic building blocks of life—in meteorites found in the Antarctic.

The laboratory examines lunar samples to find evidence of organic material, attempts to create molecules which may have existed in the Earth's or other planets' atmospheres prior to life, and examines pristine meteorite samples for evidence of organic matter.

NASA supports this research in a variety of ways. The space agency has provided Ponnamperuma's team with samples of meteorites recovered from the Antarctic ice shelf, material brought from the Moon and data on the atmospheres of other planets obtained by deep space probes.

The Antarctic meteorite program was begun three years ago as a cooperative venture between the National Science Foundation and NASA. By collecting meteorites under extremely clean conditions, essentially identical to the manner by which the Apollo astronauts collected lunar samples, joint NSF-NASA teams can provide scientists with samples so free of Earth contamination that they can be examined for evidence of an organic history before the time of their Earth impact.

Because the meteorites are protected from organic contamination while lying in the Antarctic ice and because the collection process prevents future organic contamination, Ponnamperuma considers them "the only prebiotic matter we have laid our hands on." The purpose, Ponnamperuma said, "is to find out whether in this meteorite, in this sample, there are any amino acids, any hydrocarbons."

Ponnamperuma's team has been very successful in this venture. The team has used gas chromatograph techniques to identify both right-handed and left-handed molecules of amino acids. The handedness refers to the direction to which a beam of polarized light would turn if shone through a solution of the dissolved material.

The Antarctic meteorites have provided strong evidence of both right and left-handed amino acids. Since all life forms on Earth contain only left-handed molecules, the pre-organic material found in the meteorites had to be formed somewhere else.

"The processes we postulated as taking place on the Earth before life began seem to have taken place somewhere else also," Ponnamperuma said. "What this implies is that all those events which led to life may be common in the universe, so what we said happened on the Earth may be happening somewhere else."

The meteorites which Ponnamperuma's team uses are about 4.5-billion years old. The oldest Earth material which has been identified is 3.75-billion years old and some of it shows evidence of organic matter.

"I think the conditions are such that perhaps life exists only on Earth," he said. "But what about the billions of other solar systems. There's no question that there must be innumerable possibilities for life beyond the Earth."

In addition to the sample analysis program, the chemical evolution laboratory also works to reproduce the atmospheres of other planets. Ponnamperuma is working with data provided by the Voyager Jupiter encounter to simulate that planet's outer atmosphere in a laboratory bottle. "If we simulate a Jovian atmosphere in our lab, we can come up with some of the colors we've seen on Jupiter, some of those reds and yellows. These colors are made by various molecules but can be synthesized in a Jovian atmosphere," he reported.

The important aspect of this research, Ponnamperuma said, is that "if you have an atmosphere, if you have a source of energy—and we've seen pictures of lightning on Jupiter—organic molecules can be synthesized."

The laboratory also is proceeding with simulations of the Saturnian atmosphere and that of the major Saturn moon, Titan. These simulations are being conducted now in the hope of being able to compare results with that of the upcoming Voyager Saturn encounter this November.

The meteorite program is administered by the National Science Foundation, Washington. The samples are controlled by NASA's Johnson Space Center, Lunar and Planetary Division, in Houston. So far the program has produced as many meteorites in three years as had been collected in all years previous.

Cloud Experiment Deferred

An experiment scheduled to fly as part of a Spacelab payload in 1982 has been deferred by NASA. The project involves the design and construction of an atmospheric cloud physics laboratory that would have used the zero gravity of space to study basic cloud physics phenomena.

Technical problems in the transition from ground laboratory to a space flight environment have resulted in increased cost and schedule risks to the extent that NASA officials shelved plans to fly the experiment on an early Space Shuttle mission. Instead, the specially-built equipment will be used in ground-based laboratories in the agency's weather and climate research programs.

NASA's Marshall Space Flight Center is managing the program and the General Electric Co. Space Division, Philadelphia, is the systems contractor for the flight hardware. Although the General Electric contract will be terminated, NASA will continue working with the scientific community in a two-year evaluation of space hardware and further cloud physics experiments. NASA scientists are hopeful that with further evaluation and study a cloud physics experiment may be possible on a future Spacelab mission.

More from Saturn—In a picture improved by computer processing, the structure of the Saturnian ring system is seen in new detail. Beyond the tip of the A ring (the outer visible ring) can be discerned the thin band of the newly discovered F ring and beyond that, Saturn's 11th moon S-1, 1979. The picture was made on August 31, 1979, when the Pioneer 11 spacecraft was 943,000 km from Saturn. The moon Tethys is seen above the rings.

Sounding Rockets Study Eclipse

Seven sounding rockets were launched from the San Marco launch platform off Kenya, Africa, in February to study a total solar eclipse visible in that area.

The instrument-carrying rockets were two Nike Black Brants, two Astrobee Ds and three Super Arcas. The Astrobee and Arcas rockets carried payloads from Pennsylvania State University, University Park, Pa., and the Nike Black Brant payloads were from the Los Alamos Scientific Laboratory in New Mexico.

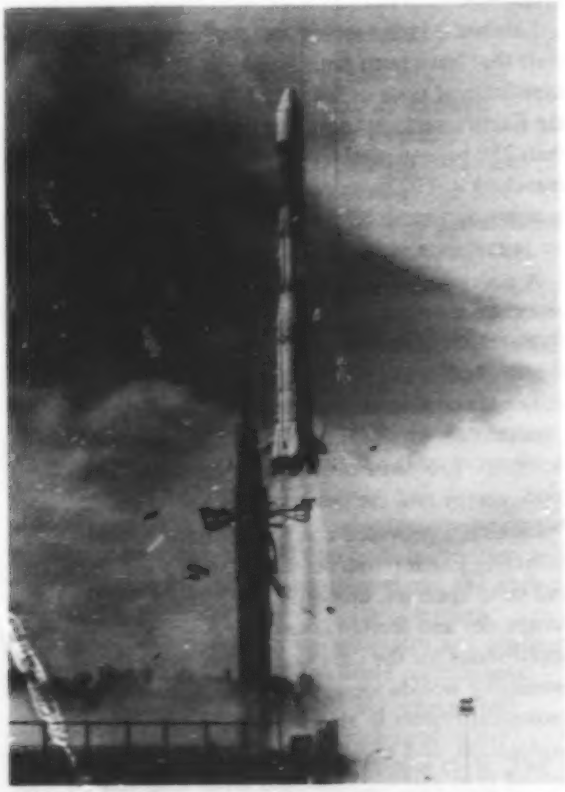
An experiment of Johns Hopkins University, Baltimore, to measure the ultraviolet zodiacal light from the solar corona rode "piggyback" on a Black Brant. The instrument packages were carried to an altitude of approximately 330 kilometers. A parachute-deployment technique was then used to make measurements as the instruments descended through the atmosphere.

Primary objective of the launches was to study changes in the electrical structure of the Earth's middle atmosphere and the temperature distribution in the solar corona during an eclipse, which was not observable in North America.

The total eclipse began off the west coast of Africa and moved across the continent. The launch platform was in total eclipse for a period of about 10 minutes.

The University of Rome's Center for Aerospace Research operates the San Marco Equatorial Mobile Range, a coastal rocket launching site in the Indian Ocean, about 4.8 km off the coast of Kenya and about 8 km south of the eclipse centerline.

NASA's Goddard Space Flight Center is managing the 1980 Solar Eclipse Program for the Office of Space Science. Wallops Flight Center is supporting the Goddard effort. For the Penn State payloads, Wallops is supplying the rocketry and instrumentation. For the Los Alamos experiment, Goddard and Wallops are supplying the rocketry and range support. Sandia Laboratories of New Mexico is providing payload integration, launch and recovery support.



European Thrust Into Space—Debris flies as the Ariane LO1 booster rocket lifts off from the Kourou space center in French Guiana, the first of four planned test flights. The picture of the Christmas Eve launch by the European Space Agency was released by the ESA in January. The project is designed to give its eleven participating countries the capacity to send telecommunications satellites into orbit and make them less dependent on the United States.

Studies Predict Growth in Telecommunications

Demand for telecommunication services in this country, with an increasingly prominent role for space satellite video and data communications traffic, is expected to grow fivefold by the turn of the century, according to recent studies.

The studies, conducted for NASA by the U.S. Telephone and Telegraph Corp., New York, N.Y., a subsidiary of International Telephone and Telegraph Corp., and by Western Union Corp., Upper Saddle River, N.J., show that demand for conventional voice services—message-toll service and private-line traffic—will continue to predominate.

By the turn of the century, as much as one-fourth of all long-distance voice traffic may be carried by satellites, as well as half of all data and video traffic.

The studies were done in conjunction with NASA's recently announced decision to renew programs directed at advanced communications satellite research and technology. Primary emphasis is on developing technology needed to open the 20/30 gigahertz (GHz) frequency band for commercial use during the next two decades in a cost-effective and spectrum-conserving manner. The band has not to date been used in this country.

The recently concluded studies show that by the early 1990s growing demand for long-distance telecommunications services will have saturated the nation's existing domestic satellite capacity in the bandwidths at 4–6 GHz (C-band) and 11–14 GHz (Ku-band). To accommodate this expected rapid growth in demand, more versatile satellites that have higher capacity and operate in the 20/30 GHz band, as well as in currently used bands, will be required.

A major attraction of the 20/30 GHz band, called Ka-band, is the broad frequency range allocated to communications satellite use—five times the band allocated at C-band or Ku-band. Using the Ka-band, advanced technology satellite systems would have message capacities of 50 to 100 times those operating in the C-band.

The studies conclude that most data-services traffic will originate and end at terminals served by computers, with executive videoconferencing expected to become a partial substitute for business travel by the year 2000. By then, 90 percent of all telecommunications traffic will require real-time, or in instantaneous service. The remaining 10 percent, such as electronic mail delivery, will be non-real-time needs.

Management of the NASA advanced space communications research and technology work is assigned to the Lewis Research Center, Cleveland.

Stirling Engine Under Inspection—NASA Headquarters officials concerned with energy conservation applications are shown discussing a model of the proof-of-concept Stirling research engine. Left to right are: Paul R. Miller, Manager of Conservation and Fossil Energy Systems; Dr. Walter B. Olstad, Acting Associate Administrator of the Office of Aeronautics and Space Technology; and Donald A. Beattie, OAST Energy Systems Division Director. The engine, designed and built by Jet Propulsion Laboratory under OAST sponsorship, offers the potential of high energy conversion efficiency, multi-fuel capability and low emissions.

Landsat 2 Ceases Operation

After five years of systematically studying the Earth's resources and environment from 920 kilometers in space, the NASA Landsat 2 spacecraft has been retired from operation because of a wear induced-failure of its primary flight control mechanism.

A two-month effort to keep the spacecraft pointed toward the Earth using other onboard flight assisting devices has proved unsuccessful. NASA engineers have placed the spacecraft in an engineering test mode for continuing evaluation of the attitude control problems. Landsat 2, launched Jan. 22, 1975, had a design lifetime of one year. Landsat 3, launched in March 1978, will continue to provide data required by more than 400 domestic and foreign Earth resources programs.

Landsat 2 is the second in a series of three spacecraft that have been launched by NASA carrying experimental systems for remotely sensing features on the Earth's surface and collecting data from more than 250 beacon platforms in remote areas. Landsat 1, launched in 1972, was retired in early 1978. A fourth—and more advanced—Landsat is scheduled for launch late next year.

A major asset of the Landsat system is its repetitive observation which makes possible the detection of short-period changes—as frequently as every nine days using two satellites.

The three most important potential uses of the Landsat data identified so far correspond to three of the major problems confronting the world today—food, energy and the environment.

Landsat 2 provided a very important function by collecting Earth resources information used by federal and state agencies, domestic and foreign private companies and foreign countries. Among the diverse applications for the data was that of using it for estimating worldwide agricultural production, geological studies in relation to oil and mineral exploration, and water resource studies such as water run-off from melting snow and water distribution. The satellite has been valuable for map making, especially in remote areas where existing maps were found to be in error. Because of its rapid response capability, Landsat 2 data has been used in assessing such disasters as an oil well blowout in the Gulf of Mexico, flooding and volcanic eruptions.

Three NASA tracking and data acquisition facilities are equipped to receive sensor data from the Landsat spacecraft. The Landsat facilities at Goldstone, Calif., and at Goddard Space Flight Center, Greenbelt, Md., can receive sensor and platform data directly from the spacecraft whenever it is in direct line-of-sight. The primary station at Fairbanks, Alaska, collects such data by commanding the satellite's tape recorders to replay during the most northerly portion of each orbit.

Data has been purchased by scientists in more than 20 countries from the U.S. Department of Interior's Earth Resources Observations Systems Data Center in Sioux Falls, S.D.

More than 1,360,000 separate views of the Earth from NASA's Landsats have been provided to the data center, where both independent scientists and the general public may obtain material for a nominal fee.

Solar-Powered Engine/Generator

A joint government/industry team will design, fabricate and test a solar-powered, 20-kilowatt engine/generator designed for use by small communities, industries, farms, military bases and similar users. The project, sponsored by the U.S. Department of Energy, is designed to foster effective and inexpensive methods of using solar energy to produce electric power and industrial heat.

The demonstration engine will be built by the AiResearch Manufacturing Co. of Arizona, Phoenix, a division of Garrett Corp., Los Angeles, under a $1.3-million contract with the NASA Lewis Research Center. The Jet Propulsion Laboratory is developing the solar-power system, including the solar mirror and receiver.

Solar energy to power the engine/generator would be focused by a dish-shaped parabolic mirror into a receiver where the heat is absorbed to run the engine. The engine/generator unit includes a turbine, compressor, alternating current generator and gearbox selected from commercially available components.

To increase energy efficiency, the engine will include a recuperator through which heat in the turbine exhaust is returned to the engine cycle. The engine/generator also would be equipped with a combustor so that power can continue to be produced at night and when skies are overcast.

The operation of this solar Brayton engine starts with the compressor which takes in surrounding air and delivers it to a recuperator at about three times atmospheric pressure. In the recuperator the high-pressure air absorbs waste heat from the turbine exhaust and goes on to the solar receiver where it is further heated to about 1500 degrees Fahrenheit.

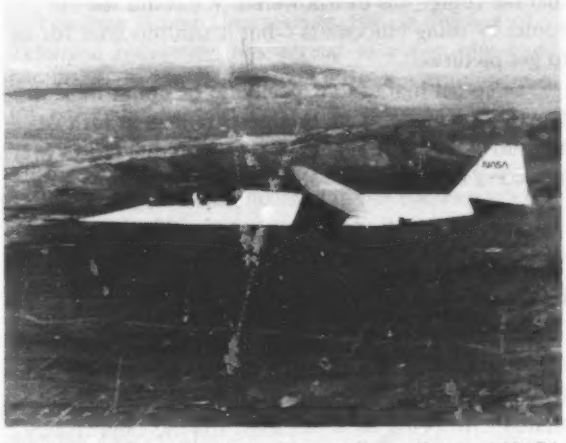
The high-pressure, high-temperature air is used to drive the turbine, which produces sufficient power to generate electricity and drive a compressor. When the Sun's intensity drops, the cooler air leaving the receiver is heated to 1500 F in a combustor placed in the ducting to the turbine.

The solar thermal generator could perform as the user's primary source of electric power or could be connected to an existing utility grid.

Major components of this solar Brayton power system will be assembled at the NASA Parabolic Dish Test Site at Edwards, Calif., where the complete system is to undergo testing in the spring of 1981.

The Sun is potentially the greatest source of usable energy available to mankind, delivering the equivalent of more than 150 million kw of power to Earth continuously. On clear days in sunny climates, the intensity of solar energy delivered to the Earth's surface can attain the equivalent of one kw per square meter.

"The challenge and the opportunity lie in focusing and collecting this potent source of energy in ways that are both technologically and economically



AD-1 Flight Tests Continue—The small, needle-nosed NASA Ames/Dryden research aircraft is going through its paces at the Dryden center. Beginning in December, the AD-1 has been tested at high and low speeds, with the wing pivoted at oblique angles to the fuselage, a concept that could be applied to the design of future jet transports. Dryden research pilots Tom McMurtry and Fitz Fulton have alternated at the controls.

feasible," said Jack A. Heller, lead Lewis engineer on the project.

"Many earlier attempts at harnessing the Sun's energy were technically successful to varying degrees." Heller said, "but were abandoned because they could not compete in terms of cost with cheap petroleum derivatives, natural gas and other fossil fuels. Today, dwindling supplies and rapidly rising costs of such fuels offer compelling reasons for development and application of clean, infinitely-renewable energy from the Sun."

Comet Barely Visible

Three scientists at the Marshall Space Flight Center reached part of their goal in late January when they set up a watch for Comet Bradfield. They saw it but couldn't get pictures.

Dr. G. A. Gary and W. F. Fountain worked with Dr. C. R. O'Dell, Marshall's associate director for science, in the attempt to observe the comet with the echelle spectrograph—which was used successfully in observing Comet West, the previous bright comet.

A lot of factors worked against the team, according to Dr. Gary, principally the weather. The sky was overcast much of the time, and humidity on cloud-free nights diffused the image of the comet.

"It was about a magnitude dimmer than anticipated," Dr. Gary said, "and the Moon was so bright that the comet was overpowered. We could see the comet by using binoculars—but it was too faint for us to get pictures."

The comet had been expected to be about third or fourth magnitude at its brightest, fading to fifth or sixth in early February. In comparison, the North Star is second magnitude.

Competition for Student Experiments

NASA has issued a request for proposals for the administration of a Shuttle Student Involvement Project. It is a nationwide competition for secondary school students, to begin in September, for the opportunity to submit proposals for scientific and engineering experiments to be flown on the Space Shuttle in late 1981 or 1982.

A similar program to involve college-level students is being developed. Details on that activity will be forthcoming later this year.

Working with NASA officials, the contractor will formulate rules for the secondary school competition and define 10 regions from which semifinalists will be selected. The contractor also will devise entry/application forms and project rules and manage the actual competition.

During a similar competition held prior to the Skylab mission, over 51,000 packages of material were mailed to interested students and more than 3,400 proposals for experiments were received. The evaluations led to 19 experiments selected for flight aboard Skylab. The spider activities with Arabella and Anita testing their ability to spin webs in weightlessness was a Skylab student experiment.

The student involvement project is part of a long-standing and continuing NASA program to involve the nation's secondary school students in creative scientific activity. NASA participation at the secondary-school level began in 1961 with science fairs.

The Space Shuttle competition will be conducted so that entries in the 10 regions will be selected (20 per region) in a semifinalist competition. Winning entrants from the regional competition will meet to discuss their proposals. Following the regional seminars, up to 10 proposals in each region will be selected for final judging. From these approximately 100 regional selections, 20 winning entries will be selected. NASA will retain the final decision as to whether or not an experiment flies aboard the Space Shuttle.

In addition, NASA will attempt to match student proposers with industrial or other non-NASA sponsors who will support the development and post-flight analysis of student experiments. NASA may also agree to provide assistance to individual winners in the event that no industrial/institutional support can be found.

Prior to any development work, students whose proposals have been selected for flight and their institutional/industrial advisors will attend a seminar at the Kennedy Space Center, to discuss their projects with other students, professional scientists and NASA officials.

The primary difference between this competition and previous competitions such as the Skylab student experiments is that the Shuttle Student Involvement Project is planned as an annual program rather than a one-time only event. Other differences include the expected participation from associated universities and associated industry sponsors.

NASA-Sponsored Solar Research—Working under a grant from the Marshall center, Dr. Juliette Ioup (left) instructs students from Xavier University in New Orleans on instruments used to gather solar radiation data. The solar project at Xavier is the first of its type in the New Orleans area and is part of Marshall's research grant programs for colleges and universities with predominantly minority enrollments.

Gamma Ray Observatory Experiment

The Gamma Ray Observatory proposed for initial funding in NASA's budget for Fiscal Year 1981 will carry as one of its five on-board experiments an instrument developed by the Marshall Space Flight Center.

The device, called a "Burst and Transient Source Experiment," is being designed as a highly sensitive all-sky monitor for the observatory, which is under management of the Goddard Space center. The satellite is scheduled for launch by the Space Shuttle in 1985.

The Marshall experiment will measure the frequency and intensity of gamma ray bursts and transient sources, astronomical phenomena that are presently little understood. Gamma rays are photons, just as light and radio waves are, but with extremely high energy levels.

The experiment will consist of six detectors, with a total weight of 408 kilograms, mounted on the periphery of the observatory, which will be 4.6 meters in diameter, about 7.6 m. long, and weigh approximately 9,071 kg.

Principal investigator for the experiment is Dr. Gerald J. Fishman, of the center's Space Sciences Laboratory. Co-investigators are Dr. Thomas Parnell and Dr. Charles Meegan. Marvis Sanders is project manager and Dr. Charles Wyman is experiment engineer.

"Our experiment is designed to look at the entire sky for gamma ray bursts and transient sources that appear at various times in different parts of the sky," Dr. Fishman said. "There are many theories to explain where these phenomena originate, but until we have more information regarding their spectral qualities and time variability—and until we can locate them more precisely—we really don't know what is causing them." Gamma ray bursts last from a fraction of a second up to 20 seconds, transient sources from a few hours up to several weeks.

A definition study of the Marshall experiment is expected to be completed by September, after which will come detailed design and construction. The experiment is scheduled to be delivered to Goddard for integration into the observatory one year prior to launch.

Contractor News

Sperry Support Services, a division of Sperry Corporation, of Huntsville, Ala., has been awarded a contract to provide simulation and data systems support services to Langley Research Center. The three-year agreement is valued at approximately $4.6 million. The work involves the development, operation and maintenance of flight simulators, including real-time digital programs for solving research problems, aerodynamics and space flight.

Teledyne Brown Engineering, Inc., a division of Teledyne Industries, has agreed to a cost-plus-fixed-fee contract to install payload checkout equipment at the Kennedy Space Center. The contract has an estimated total cost of over $1 million, extending through December 31, 1980. Both hardware and software elements are included in the contractor's assignment to install, test and calibrate a payload checkout unit and ground support equipment used to assemble and test instruments for Spacelab payloads, all to be performed within the Operations and Checkout building at KSC.

Computer Sciences Corporation, of Falls Church, Va., has won a contract to provide computational analysis and programming support services at the Langley Research Center. The three-year agreement is valued at approximately $3 million. The work will be performed in support of basic and applied aerospace research at Langley, in areas of analytical computing, engineering flight simulation and research data reduction.

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) and Employer	Title	Patent No.	Installation
Thomas B. Fryer, NASA Ames	Induction powered biological radiosonde	4,186,749	ARC
Michael W. Sievers, Caltech/JPL, Pasadena, CA	High-speed data link for moderate distances and noisy environments	4,187,394	NRO/JPL
Edward R. Caro, Caltech/JPL, Pasadena, CA	High power RF coaxial Swith	4,187,416	NRO/JPL
Robert C. Clauss, Rex B. Quinn, Caltech, Pasadena, CA	Dielectric-loaded wave guard circulator for cryogenically cooled and cascaded master waveguide structures	4,187,470	NRO/JPL
Richard M. Dickinson, Caltech/JPL, Pasadena, CA	Microwave power transmission beam safety system	1,487,506	NRO/JPL
Emmett L. Bryant, NASA/Langley	Noncontacting method for measuring angular deflection	4,189,234	LaRC
Charles B. Wolf, Thomas N. Myer, Westinghouse Elec. Corp., Trafford, PA	Liquid reactant feeder for ARC assisted metal reduction reactor	4,188,368	NRO/JPL
William R. Hood, NASA/Langley	Detection of the transitional layer between laminar and turbulent flow areas on a wing surface	4,188,823	LaRC
Norman B. Reilly, Joel G. Smith	Satellite personal communications system	4,189,675	NRO/JPL
Cecil J. Marek, Larry P. Cooper NASA/Lewis	Supercritical fuel injection system	4,189,914	LeRC
John E. Greenleaf, Robert W. Delaplaine, NASA/AMES	Sweat collection capsule	4,190,060	ARC
George M. Weyler, Jr., NASA/Marshall	Method of manufacture of bonded fiber flywheel	4,190,626	MSFC

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January 17	Atlas Centaur	ETR	DOD Navy. Reimbursable
SMM-A	February 14	Delta	ETR	NASA. Scientific Solar Maximum Mission.
NOAA-B	May	Atlas-F	WTR	NOAA Weather. Reimbursable.
Navy-20	July	Scout	WTR	DOD Transit. Reimbursable.
GOES-D	August	Delta	ETR	NOAA Weather. Reimbursable.
Intelsat V-A	September	Atlas Centaur	ETR	Intelsat communications. Reimbursable.
Navy-21	October	Scout	ETR	DOD Transit. Reimbursable.
SBS-A	October	Delta	ETR	Satellite business systems. Reimbursable.
FLTSATCOM-D	November	Atlas Centaur	ETR	DOD Navy. Reimbursable.
Intelsat V-B	December	Atlas Centaur	ETR	Intelsat communications. Reimbursable.

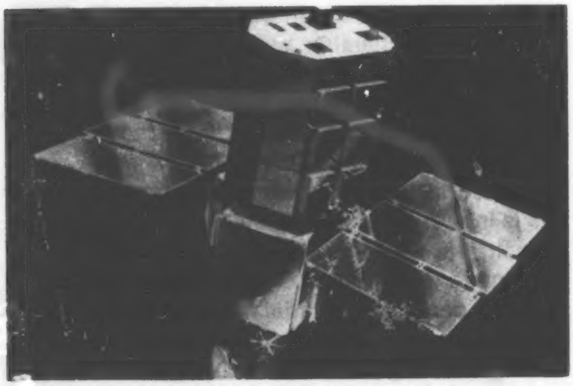
Did You Know?

SERT II of Lewis has demonstrated the durability of a well-designed spacecraft, passing its 10th year of space testing this winter. Designated the Space Electric Rocket Test II, the craft was conceived, developed and launched by the Lewis Research Center to evaluate long-term effects of electrical propulsion systems and it carried into space an ion thruster system invented by Lewis' Harold Kaufman. SERT II performed its tests in 1970, was reactivated in 1973 to restart the ion thrusters, but was little used from 1974 to 1978. Last year, with its solar array moved into full sunlight, the venerable experiment was revived and is still proving useful after a working decade.

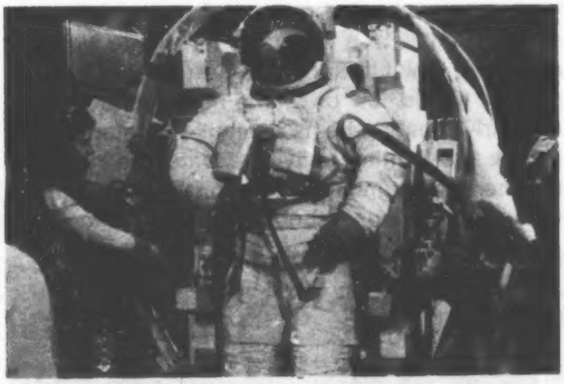
Smokers are wanted at the Johnson Space Center, at least temporarily and in the interest of science. The JSC Cellular Analytical Lab has been recruiting healthy cigarette smokers between the ages of 30 and 60 to participate in a project studying the developmental aspects of lung cancer. The Lab, in cooperation with Baylor College of Medicine and the National Cancer Institute, will be analyzing sputa from the natural section of the lungs and volunteers will be paid $10 for each sputum specimen taken.

Centralized controls is the energy savings method at Ames Research Center, with the air handling units and chiller units of the air conditioning systems upgraded through computers. Boiler systems for heating will be added as well as power and gas metering in selected buildings for greater savings. The technique was cited in Idea Clearinghouse for March.

Nine women employees of the Jet Propulsion Laboratory are now rated as Certified Professional Secretaries (CPS) as approved by the National Secretaries Association (International). The most recent addition to the CPS ranks is Merilyn Winsor of JPL. The rating is achieved by successful completion of a two-day, six-part examination given annually in May.



Safely in Orbit—The first spacecraft designed specifically for the study of solar flares is performing, as an artist depicts it, at the designated 574 kilometer-high circular orbit. The Solar Maximum Mission was launched on schedule on February 14 and is now detecting solar flares, using the Hard X-Ray Burst Spectrometer. All of the seven instruments aboard have been turned on. The mission is to coincide with the Solar Maximum Year, the peak of an 11-year cycle when the Sun's surface has particularly explosive activity.



The Fitting Process—Astronaut Bruce McCandless wears the Manned Maneuvering Unit as engineers and technicians at the Johnson Space Center check out its ease of movemet and efficacy. The propulsion backback suit, recalling the old Buck Rogers style, is designed to enable astronauts to work outside the Space Shuttle orbiter and possibly to repair tilework.

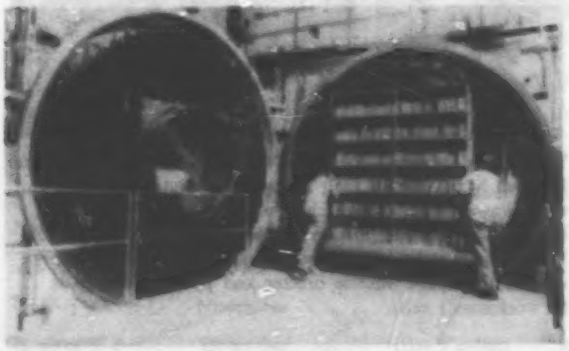
Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Book Drying Technique

At Valley Forge, Pennsylvania, General Electric Company's Space Division has a large environmental chamber for simulating the conditions under which an orbiting spacecraft operates. Normally it is used to test company-built space systems, such as NASA's Landsat and Nimbus satellites. It is also being used in a novel spinoff application-restoring waterdamaged books and other paper products and textiles.*

This unique technology transfer began in 1972 when Temple University's Klein Law Library caught fire. In the course of extinguishing the fire, almost 60,000 books, some irreplaceable, were completely soaked by tons of water from high-pressure fire hoses. Looking for a means of salvage, Temple's insurance company contacted GE's Space Division, whose officials felt that the space vacuum chamber could be effectively employed as a dryout tank. Temple's books were loaded onto wheeled racks and placed in the chamber 4,000 at a time. The technique worked and Klein Law Library's books are back on their shelves. GE is now providing the service regularly, treating items damaged by storms, floods, fire-fighting activities, waterline ruptures or other environmental conditions. An example of a badly water logged book restored to excellent condition is the rare 17th century volume shown.



When the books are in place and the vault-like door secured, chamber pressure is reduced to spacelike conditions of 1/100th of an atmosphere, promoting evaporation of water. As the water evaporates, it freezes in the near-vacuum. After 24 hours, pressure is increased to break the vacuum. Then hot freon gas is introduced to the chamber, causing the ice to melt; the water is drained off through an opening in the chamber. This process is repeated until the damaged materials are thoroughly dry. The process represents a major improvement over an existing method, which involves blotting individual pages by hand and air-drying them slowly at a cost of about $100 a volume. The space simulator process costs only $2 per book.

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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NASA Activities

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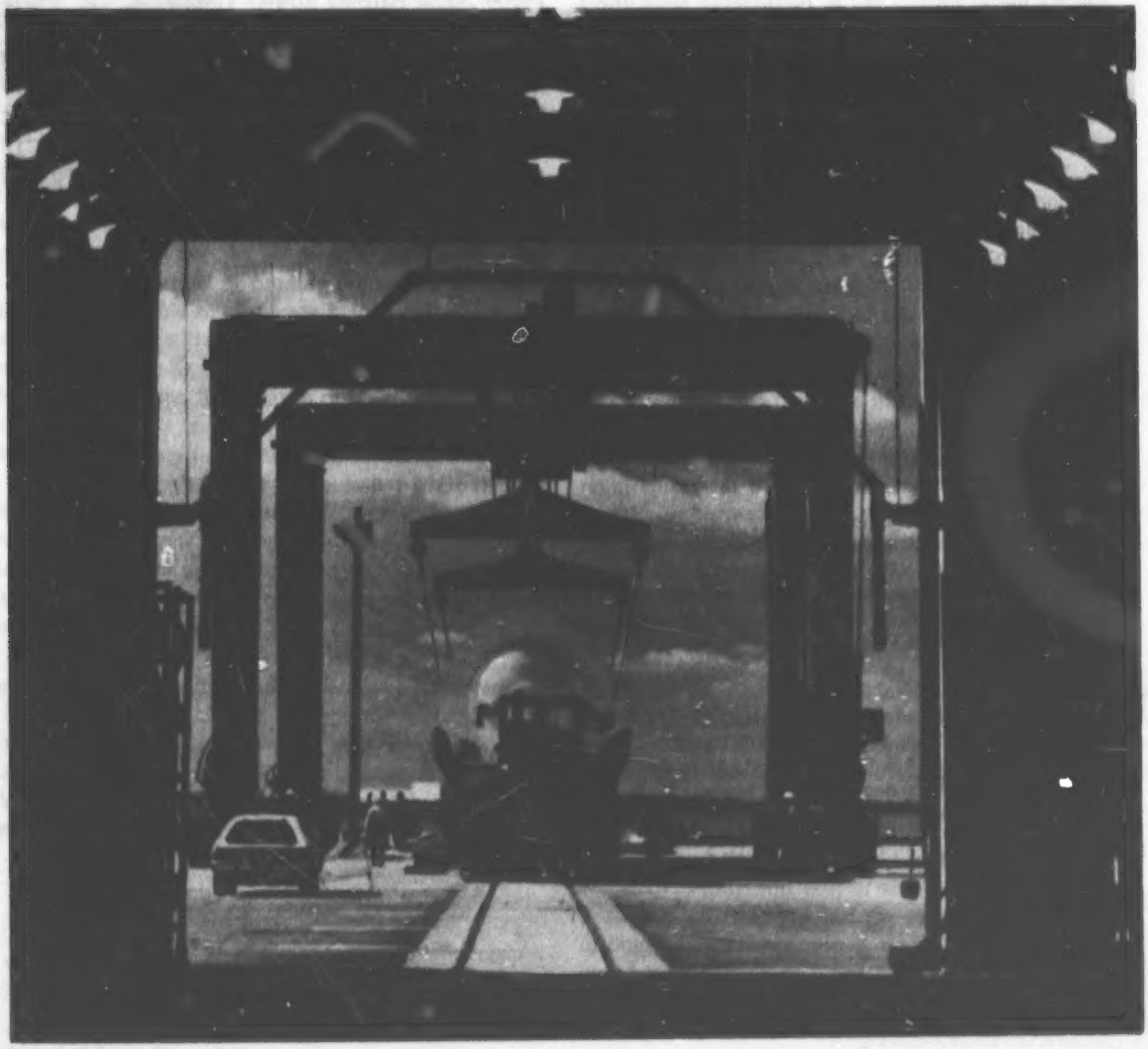

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Water Wash Awaits—A full scale simulator of a Space Shuttle solid rocket booster motor, the huge white cylinder in the background, is towed into Hanger AF at the Kennedy Space Center. Inside is a high pressure water wash, designed to clean and refurbish spent booster motors after each Shuttle flight. The simulator, made by the Key Houston Co. of Jacksonville, Fla., has been used in practicing recovery of the boosters in Port Canaveral waters since March 3.

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Letter from Washington

Dear Colleagues:

As all of you know a proposed budget for FY 1981 was announced in January and Congressional hearings have been held on its various aspects since then. As stated at the time that budget was released, we found it a positive budget which moved us forward across a broad front.

On March 31st a new proposed budget was submitted reflecting NASA's participation in the President's program to control inflation by restraining Federal spending in Fy 1981. The amended budget reflects a reduction from the original of $219 million in budget authority and $224 million in outlays.

The specific details of funding reductions will have been available to all of you before publication of this letter so I will not list them here except to note that full funding has been retained for the development of the Shuttle, the production of follow-on orbiters and for NOSS and GRO, the two new starts specified in the original budget.

The essential point to be made is that while these reductions will force deferrals of several very important elements of our programs, with resultant loss of near-term benefits, and increased risks, we believe they constitute a careful, balanced curtailment of spending in support of the President's anti-inflation program.

Although painful, these reductions are not crippling. The amended budget permits a balanced, viable national aeronautics and space program, and the world-renowned NASA team with its tradition of excellence can and will make that program a reality. We will not reach all our goals as soon as we would like, but we will reach them all.

Sincerely,

A. M. Lovelace

A. M. Lovelace

Satellite System to Study Oceans

The NASA fiscal 1981 budget contains a major new start in space applications, calling for the development of a joint civil-military satellite system for ocean monitoring.

The program, called the National Oceanic Satellite System or NOSS, is planned to be a joint endeavor of NASA, the Department of Commerce's National Oceanic and Atmospheric Administration and the Department of Defense. The satellite system will be jointly funded and managed by the three agencies.

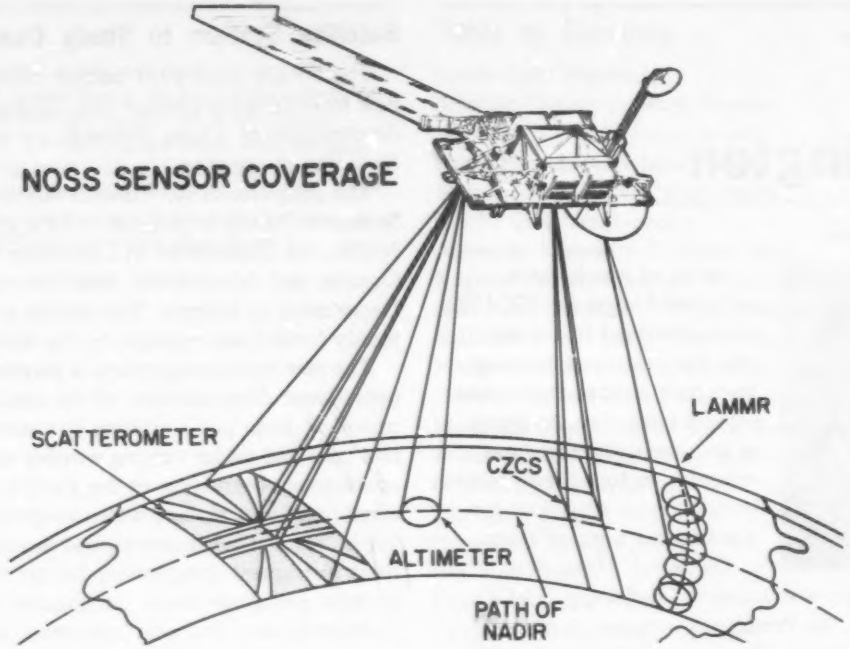
The new monitoring system is proposed as a limited operational demonstration of the feasibility of providing from polar-orbiting spacecraft—in near real time and under varying weather conditions—continuous observation of the Earth's ocean surface winds, sea state, surface water temperature, wave height, ice and other geophysical measurements. The basic instrument complement for the satellite consists of three previously flown instruments and one now in development. The new instrument is the large antenna multichannel microwave radiometer (LAMMR), with a 3.6-meter diameter antenna, a larger version of the Scanning Multichannel Microwave Radiometer flown on Nimbus 7. Primary usage of the radiometer is monitoring the sea surface temperature, wind speed and sea ice and providing atmospheric corrections for the on-board altimeter and scatterometer.

The altimeter is the same instrument flown on Seasat, except that two will be flown in the new system for redundancy to meet mission life requirements. It will monitor ocean wave parameters and ocean currents.

The scatterometer is an upgraded version of the Seasat scatterometer system. The new version will have six antennas instead of four and also redundant electronics. It will monitor surface wind velocity over the oceans.

The fourth instrument, the coastal zone color scanner (CZCS) is the same as one flown on Nimbus 7 with three additional channels and will monitor chlorophyll concentration and water turbidity distributions.

Data from the proposed satellite system, due to its coverage and timeliness, should improve the efficiency, safety and cost of ship operations, transportation, off-shore oil and gas exploration and drilling, platform operations, marine construction, commercial fishing, pollution monitoring, ice monitoring and marine search and rescue. Also, it is expected



to be especially useful in improving National Oceanic and Atmospheric Administration global weather forecasting services.

The U.S. Navy expects to use data from the monitoring system for the prediction of operating areas, ship routing, strategic operations, anti-submarine warfare, acoustic predictions, tactical ship routing and global ocean data forecasting.

Astronauts Get New Simulator

First use of a new NASA flight simulation facility will be in support of the Space Shuttle. Called the vertical motion simulator, the trainer at NASA's Ames Research Center, is designed to improve flight characteristics of many different types of aircraft. But the Shuttle has first priority.

The series of Shuttle simulation investigations will help to evaluate changes planned for the orbiter control system. The primary objective of the Shuttle modifications is to improve the control characteristics of the spacecraft in the atmospheric reentry phase and during landing and rollout.

The vertical motion simulator has an improved motion range capability over other facilities. It can more accurately reproduce the motion an astronaut at the controls of the Shuttle orbiter would feel during approach, flare and landing.

Unplanned oscillations about the pitch and roll axes are not uncommon in high-performance aircraft and normally occur at times when the pilot's workload is high, i.e., during the landing phase. The tendency for the spacecraft to develop oscillations was substantiated during approach and landing tests conducted at NASA's Dryden Flight Research Center in 1977.

Shuttle astronauts and engineers from the Johnson Space Center, and Rockwell International, Space Systems Group, Downey, Calif., will work the simulator to evaluate orbiter handling qualities with a newly developed adaptive gain device incorporated into the orbiter control system. The device was developed by Dryden center engineers and contractors after extensive flight testing in several aircraft, including the NASA fly-by-wire research aircraft.

For the Shuttle flight simulations, the pilots will sit in a replica Shuttle orbiter cockpit mounted on the moving base of the simulator. The motion drive system (electro/hydraulic) provides the pilot with the feel of the aircraft as it moves the simulator cockpit over a wide range of motions (forward and back, up and down, sideways, rolling, pitching and yawing). The range of motions available include 18 meters vertically, 12 m laterally and 2.4 m longitudinally. In addition, the cab can roll plus or minus 22 degrees from center position, pitch plus or minus 25 degrees and yaw plus or minus 29 degrees.

The cabin is equipped with a televised visual display system and a stereo audio system as well as flight instrumentation and flight controls to simulate the particular vehicle being investigated.

A computer drives the simulation system. It is programmed with the standard equations of motion relating to the motion of any object in air or space, as well as with flight characteristics and specifications of the aircraft to be simulated.

As the pilot moves the controls, electrical signals are sent to the computer which then calculates almost instantaneously the proper motion response and signals the motion drives. The computer at the same time activates the flight instrumentaton and sound system to provide the pilot with representative and realistic aircraft sounds and instrument information relating to aircraft speed, altitude, attitude position and other characteristics.

The computer also controls the visual display system. It consists of a large three dimensional terrain model (including an airport complex) and a mobile color television camera. As the simulator "flies," the computer signals the camera which moves over the model and televises the picture to the pilot through color TV sets mounted in front of the cockpit windshield. Through a special lens system, the pilot sees a picture similar to that which would appear through the windshield of a real aircraft flying over similar terrain.

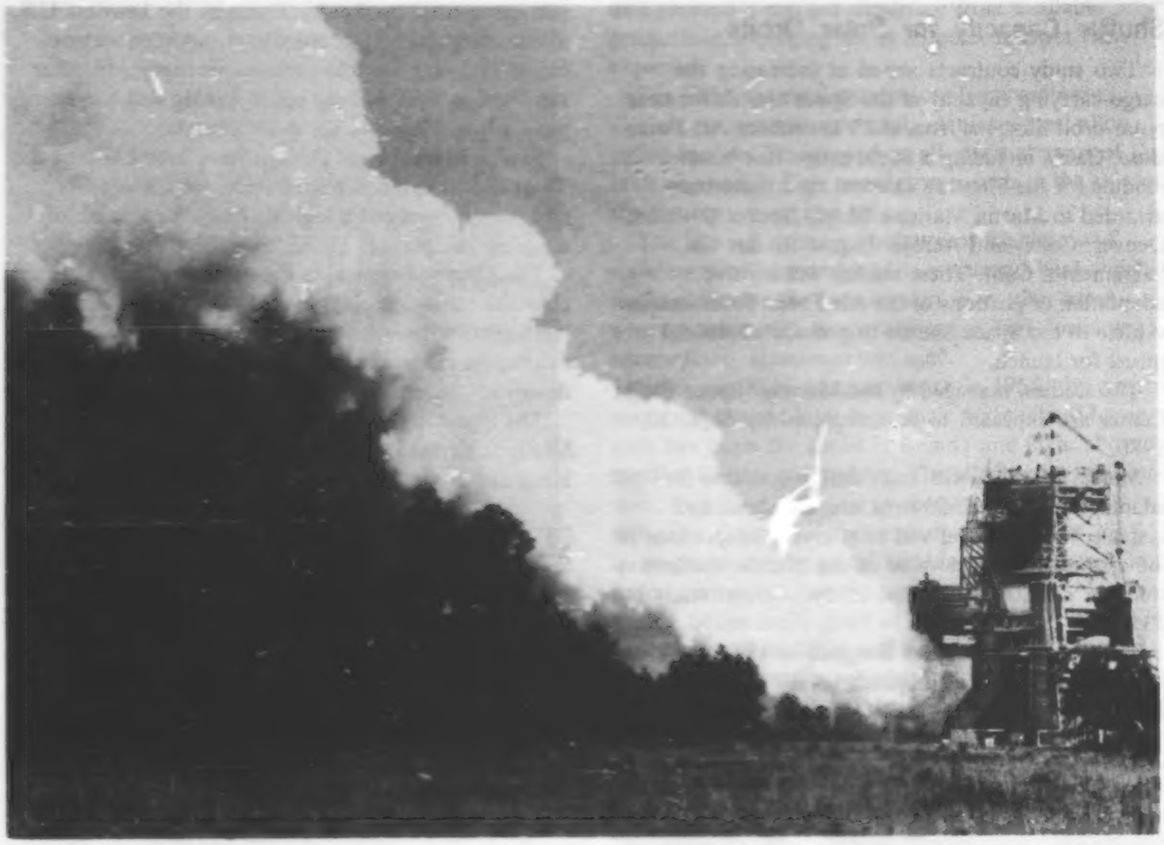
Flying NASA's research aircraft simulators is as close to real flight as the state-of-the-art permits. The pilot is presented with components of the information normally used in actual flight including instrument information aircraft sounds (engine, landing gear and wheel rumble), a realistic "out the window" visual display and the "seat of the pants" feel of the aircraft.

White House Presentation—In late March, President Carter presented the National Space Club's Goddard Memorial Trophy to NASA Administrator Dr. Robert A. Frosch on behalf of the Voyager mission team. Taking part in the Oval Office ceremony were, from the left, John Lent of the Martin Marietta Company, president of the Space Club; the President; Dr. Frank Press, White House science advisor; Dr. Frosch; Dr. Bruce Murray, Jet Propulsion Laboratory Director, and Robert Parks, JPL Assistant Laboratory Director for Flight Projects. The Goddard trophy is presented annually for outstanding contribution to U.S. leadership in astronautics.

Shuttle Simulator Due Upgrading—Astronaut Dave Griggs sits in the Space Shuttle One-G trainer simulating an orbiter vehicle in the JSC mockup and integration laboratory. An improved flight simulation facility is now operating at the Ames Research Center and Shuttle astronauts from Houston will be training in the new control system.

Laying Orbiter Tile—Rockwell International workers use a gauge to determine curvature of a portion of the Space Shuttle orbiter's upper wing surface before bonding more of the thermal protection system tile. The work is being performed at Kennedy Space Center, where the orbiter Columbia was brought last year before the tile placement was finished. Of the three high technology areas developed for the Shuttle, the tiles have been the most difficult to analyze.

Cleaning Shuttle Hardware—The main engine thrust chamber liner of the Space Shuttle is hosed down at the Rocketdyne Division of Rockwell International in Canoga Park, Calif. When the engine is ignited, liquid hydrogen at minus 423 degrees Fahrenheit cools the hardware inside while the combustion temperature in the throat of the chamber soars above 6,000 degrees in a chamber pressure of almost 3,000 pounds per square inch.



Pillows of steam issue from the NSTL test stand during main propulsion system firing.

Main Propulsion System Passes

Three Space Shuttle main engines, mounted in a main propulsion test article at NASA's test facility in Mississippi, were static fired for 535 seconds in the eighth test of the Shuttle's main propulsion system. The test came just three weeks after a similar test firing of 555 seconds duration.

The early morning test accomplished all objectives, according to officials at Marshall Space Flight Center which is responsible for developing and testing the complete propulsion system.

For the first time during main propulsion system testing the engines were gimballed (steered) while a "pogo effect" was deliberately induced so that engineers could observe the vehicle's reaction to this combination. Pogo is a phenomenon of cyclic propellant system pressures that has occurred under some conditions in earlier launch vehicles. The test is to demonstrate the engine accumulator system's capability to prevent pogo during flight.

Two periods of throttling two engines to 70 percent of rated power level with the third still at 100 percent verified the main propulsion system performance at differential throttling that is necessary during the early seconds of a Shuttle launch.

Another successful "first" in this test was a thrust vector control failure simulation to test whether redundant systems would perform properly in the event of such a failure during launch.

The test was planned for early morning in order to allow engineers to observe ice and frost conditions on the external tank when filled with supercold propellants during nighttime hours (in the absence of heat from the Sun).

Main propulsion testing is conducted for the Marshall Center by the Space Systems Group of Rockwell International, Downey, Calif. with support from Rockwell's Rocketdyne Division and Martin Marietta Corp., Denver, Colo. The test took place at NASA's National Space Technology Laboratories at Bay St. Louis, Miss.

Shuttle Capacity for Polar Orbits

Two study contracts aimed at increasing the cargo-carrying capacity of the Space Shuttle for near polar orbit missions from the Vandenberg Air Force Base, Calif., including a liquid propellant boost module for the Shuttle's external tank, have been awarded to Martin Marietta Corp., Denver Division, Denver, Colo., and Aerojet Liquid Rocket Co., Sacramento, Calif. These studies will involve adaptation of portions of the Air Force Titan launch vehicle to the Space Shuttle to provide additional thrust for launch.

The studies, managed by the Marshall Space Flight Center are expected to be completed by Sept. 30, 1980.

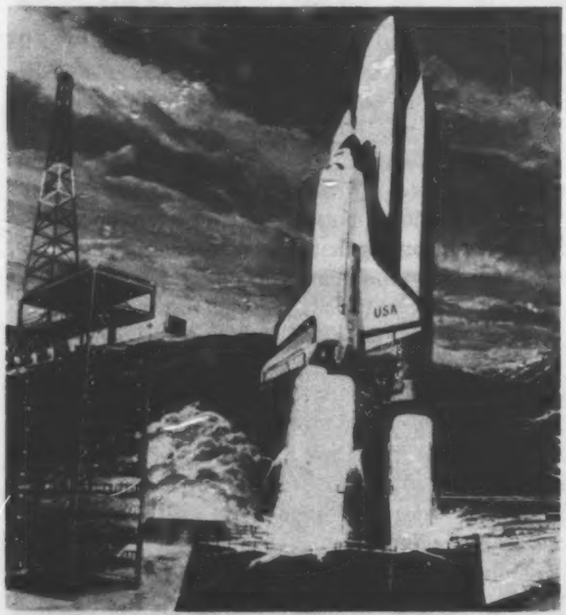
Martin Marietta will study design concepts for adaptations to the Titan structure, dynamics and systems, while Aerojet will be studying adaptations of the engines. Contract value of the Martin Marietta study is $750,000 and value of the Aerojet study is $350,000.

The Titan engines were designed in 1962 for Titan II, which was used as a launch vehicle for boosting 12 two-men Gemini spacecraft into orbit. Titan II is still being used by the Air Force as the heaviest U.S. intercontinental ballistc missile. A modified version called Titan III, launches communications and other satellites, as well as deep space Viking and Voyager payloads to Mars and the outer planets.

Martin Marietta and Aerojet have been building the Titan and its engines, respectively, for the Air Force and were considered a logical choice for the job of adapting the booster to the Space Shuttle.

The Marshall center, in the meantime, will also continue its in-house evaluation of Titan systems, methods of attaching the booster to the Shuttle's external tank, and studies to determine an optimum design for flight.

The liquid boost module is expected to increase the Shuttle's payload capability from 10,886 to 16,329 kilograms for near polar orbits.



West Coast Launch—An artist depicts the Space Shuttle orbiter, mated to its solid rocket booster and external tank, leaving a California site for near polar orbit. New study contracts awarded industry by NASA involve use of the Titan vehicle to provide additional thrust for Shuttle launches from the West Coast.

X–15's 20th Anniversary

Occupying a place of honor in the Smithsonian Institution's National Air and Space Museum in Washington, D.C., is a black, dart-like, stubby-winged craft that resembles a cross between a rocket and an airplane. The X-15 is, in fact, just that.

March 25 was the 20th anniversary of the first research flight of the X-15, the rocket plane that advanced knowledge of how man and machine function in the realm of hypersonic flight and made significant contributions to the nation's space program.

The X-15 was conceived some 25 years ago and went on to fly 199 flights in a joint NASA-Air Force-Navy research program. The craft's first research flight took place March 25, 1960; its last, Oct. 24, 1968.

During those eight and a half years it set altitude and speed records for winged aircraft that remain unchallenged. An X-15 achieved an altitude of 17,960 meters and, on another flight, a modified X-15 reached a speed of 7,274 kilometers per hour—6.7 times the speed for sound.

But altitude and speed were not the X-15's only purposes. The three X-15s served as reusable manned platforms for a range of experiments that helped advance the development of vital aeronautical and space flight systems. Materials, instrumentation, space suits and techniques were developed for NASA as well as the military. The X-15 was the latest in a series of manned rocket research planes. The first of the series—the X-1—was the first plane to fly faster than the speed of sound.

Twelve experienced military and civilian pilots flew

Setting a Record—Major Robert White, USAF, one of the prime research pilots in the X–15 program, reaches a speed of MACH 6.04, an unofficial record. The date was November 9, 1961, and the total flight time was 10 minutes.

the X-15, including Neil Armstrong, the first man to walk on the Moon, Joe H. Engle, currently an astronaut, and A. Scott Crossfield, the X-15's first pilot.

The X-15 was launched from beneath the wing of a B-52 aircraft once that aircraft had reached 13,716 m altitude and a speed of 805 km/hr.

Freed from the B-52's wing, the X-15 engine fired, rocketing the craft downrange at hypersonic speed. The flights were made over a broad expanse of desert stretching from Utah through Nevada into California. Its flight completed, the craft glided to a 322-km/hr landing on a dry lake bed at Edwards, Calif., using a conventional nose-wheel landing gear and ski-like skids at the rear.

North American Aviation, El Segundo, Calif., (now part of Rockwell International Corp. Pittsburgh) built the 15-m long X-15s after extensive wind tunnel and structural component tests demonstrated the basic validity of the design.

Virtually all of the pressures and forces measured in flight were found to be in agreement with the wind tunnel predictions. In contrast to the accurate predictions of hypersonic aerodynamic forces, however, little was known about turbulent heating rates for vehicles in this speed range. Measured flight data showed a marked departure from available predictions, averaging about 35 percent lower than expected.

The X-15 required a departure from ordinary aircraft construction materials. A nickel-steel alloy called Inconel X was used on all external areas of the craft exposed to high temperatures such as the skin of the fuselage, wing and tail.

The internal primary structure of titanium and stainless steel was designed to withstand heat which might penetrate the Inconel skin. For other areas, where neither high temperatures nor high loads were encountered, aluminum was used.

When the X-15 program began in 1954, there were many unknowns about hypersonic flight (flight faster than five times the speed of sound) and flight above most of Earth's atmosphere. The effects of weightlessness, high heat rates, steep reentry angles, the difficulty of attitude control in space, all were questions that only actual flight in the hypersonic, low space environment would answer.

One of the major goals of the X-15 program was to explore the capabilities and limitations of a human pilot in an aerospace vehicle. The X-15 showed that a human pilot can play an important role in the safe and successful completion of a mission. The basic

One of the Few—Astronaut Joe Engle, Space Shuttle backup crew commander, visited the National Air and Space Museum on the 20th anniversary of the X–15's first research flight. Engle flew the rocket powered airplane sixteen times.

philosophy of piloted aircraft operation was shown to be just as applicable to the realm of hypersonic and space flight as it is to supersonic flight.

Analysis of the first 44 flights showed that 13 of them would have failed in the absence of a human pilot together with the various redundant systems provided in the airplane. There were only a few examples where pilot error degraded the mission performance. The only fatal crash of an X-15 occurred in 1967.

The broad positive finding of the program, however, was that the capabilities of the human for sensing, judging, coping with the unexpected and employing a fantastic variety of acquired skills remains essentially undiminished in all the key problem areas of aerospace flight.

When originally designed, the X-15 was expected to generate extremely valuable information about the realm of hypersonic flight. While it did indeed provide a wealth of such information, the X-15 program's greatest contribution was to knowledge of space flight.

One significant contribution to the space program was the demonstration that simulators could be used extensively for crew training. There were no two-seat X-15s so the pilots trained in simulators. The success of this method paved the way for similar all-out use of simulators in the space program.

Government and industry teams, working together on the X-15 program to solve unprecedented problems, became an invaluable asset in the space program. Scientists attached instruments to the X-15 and loaded others aboard in modified compartments. Astronomy, Earth science, solar studies and other fields all were given a boost by the X-15. The program produced more than 700 technical documents, 200 of which reported general research that would not have been undertaken otherwise. Total cost of the X-15 program, including construction of the three aircraft, was about $300 million.

In addition to the aircraft on display at the Smithsonian, X-15 number 2 is on display at the Air Force Museum at Wright-Patterson Air Force Base, Dayton, Ohio. The third craft was destroyed in the 1967 crash.

Other X-15 pilots were: Joseph A. Walker, NASA; Robert M. White, Air Force; Forrest S. Petersen, Navy; John B. McKay, NASA; Robert A. Rushworth, Air Force; Milton O. Thompson, NASA; William J. Knight, Air Force; William H. Dana, NASA; and Michael J. Adams, Air Force, who died in the 1967 accident.

Antarctic Meteorite Searchers Busy

Researchers from NASA and the National Science Foundation have found what looks like a promising new meteorite field in the Antarctic. For the past four years meteorite hunters have been ranging over the Allen Hills area of Antarctica looking for and retrieving meteorites. The number of meteorites found has increased substantially the number available for research, especially in the area of organic chemistry.

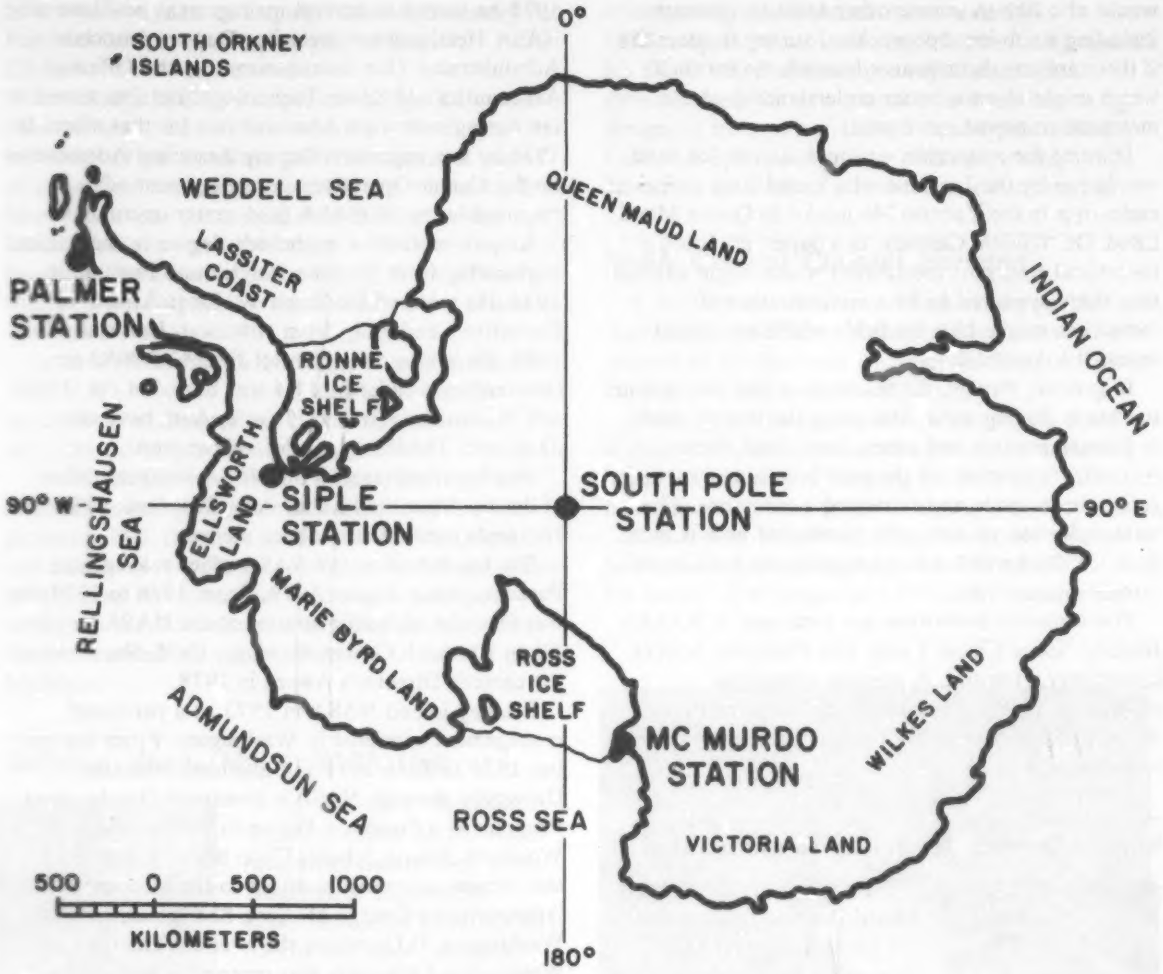
The new meteorite area, near Reckling Peak, in a previously unexplored region of the giant ice continent, is about 320 kilometers north of the U.S. station at McMurdo Sound.

The meteorite research and retrieval is carried out by university and government researchers led by Dr. William Cassady, University of Pittsburgh, and funded by the National Science Foundation. The teams have included members of the Japanese polar research team and members of a group from Johnson Space Center, Houston.

The meteorites are collected and treated in much the same manner as the lunar samples which were retrieved by the Apollo astronauts. Because of the remarkable preserving characteristics of the ice shelf, Dr. Cyril Ponnamperuma, chemical evolution researcher at the University of Maryland, College Park, has said these Antarctic meteorites are the best extraterrestrial samples yet found.

The ice, cold and dry conditions of the Antarctic serve to preserve the meteorites, many of which have been there for hundreds of thousands of years, in the

Searchers and a Find A team from the National Science Foundation leaves a Navy helicopter to pick up a meteorite, starkly visible on the Antarctic ice. NSF and NASA meteorite hunters say they are collecting the best extraterrestrial material ever found.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same condition as they were when they first entered Earth's atmosphere. For this reason, researchers like Ponnamperuma can examine the samples for evidence of an organic history predating their arrival on Earth.

The new meteorite area is perhaps three or four times as large as the Allen Hills area, according to associate lunar curator John Annexstad, who, along with other members of the NASA-National Science Foundation team, discovered the field in the recent Antarctic summer season. The continent of Antarctica is about as large as the United States and Mexico combined with nearly 98 percent of the surface covered by ice.

Annexstad said the new area, consisting of two different fields tentatively identified as Reckling Peak Moraine and Elephant Moraine, will take several seasons to survey. "It's just about at the limit of helicopter support. We used snowmobiles to get there from the Allen Hills area this time," he said. The new area is more promising than the Allen Hills area and more dangerous. "This area (Reckling Peak) contains many crevasses, and what we may find is that all the meteorites are lodged at the bottom of one of these," Annexstad said.

During the initial reconnaisance of the area, 27 meteorites were spotted. "And those were spotted while we were actually looking around at the site. We weren't really looking for them, they just caught our eye," Annexstad added.

The NASA-National Science Foundation team would also like to pursue other areas of research including a sub-ice topographical survey to ascertain if there are any disturbances beneath the ice shelf which might allow a better understanding of the meteorite transport mechanism.

Hunting for meteorites on the Antarctic ice shelf was begun by the Japanese who found large caches of meteorites in the Yamato Mountains in Queen Maud Land. Dr. William Cassady, in a paper, proposed a theoretical transport mechanism which might explain why there appeared to be a concentration of meteorites on the blue ice fields which are dotted across the Antarctic.

In general, though, the teams have had tremendous success in finding meteorites using the theory. And, as Ponnamperuma and others have cited, these Antarctic meteorites are the next best thing to actually going out in space and retrieving a meteorite. The total collection of Antarctic meteorites now is more than 1,600, of which a large number are considered rare or unique types.

The Antarctic meteorites are processed at NASA's Johnson Space Center Lunar and Planetary Science Laboratory, Houston. A steering committee established by the NASA-National Science Foundation team supervises distribution of the samples to researchers.

Kilgore Named Associate Administrator

Edwin C. Kilgore has been named Associate Administrator for Management Operations at NASA Headquarters. The appointment is effective immediately.

Ann P. Bradley has been named Deputy Associate Administrator for Management Operations, effective April 6.

Kilgore has been acting Associate Administrator for Management Operations since August 1979. Prior to that he had been Director for Management Operations at NASA's Langley Research Center since 1975.

Kilgore joined Langley's engineering division in 1944 as a development design engineer. In 1954 he was named technical assistant to the machine design branch. He became assistant chief of the engineering service division in 1960 and chief of the flight vehicles and systems division in 1968. From 1970 through 1975 he served in several management positions at NASA Headquarters including Deputy Associate Administrator (for management) in the Office of Aeronautics and Space Technology. He also served as the Acting Associate Administrator for that office. In 1974 he was appointed Deputy Associate Administrator for Center Operations, a management office responsible for all NASA field center operations.

Kilgore received a bachelor's degree in mechanical engineering from Virginia Polytechnic Institute in 1944. He received the Roger W. Jones Award for Executive Leadership from American University in 1978. He is also a recipient of NASA's Medal for Outstanding Leadership. He was born Jan. 24, 1923 at Coeburn, Va. He and his wife, Ann, have two daughters. The family resides in Hampton.

Bradley is manager of the NASA Resident Office at the Jet Propulsion Laboratory, Pasadena, Calif. Her replacement has not been named.

She has served as the NASA office manager at Pasadena since August 1979. From 1976 to 1979 she was Director of Administration at the NASA Dryden Flight Research Center, Edwards, Calif. She received the center's Director's Award in 1978.

Bradley joined NASA in 1973 as a personnel management specialist in Washington. From September 1974 to June 1975 she attended Princeton University through NASA's Executive Development Program as a Princeton Fellow in Public Affairs in the Woodrow Wilson School. Upon her return in 1975, she became executive assistant to then Deputy NASA Administrator George M. Low. She is a native of Washington, D.C., where she attended George Washington University and received a bachelor's degree in administration.

Duff New Director of Public Affairs

Brian M. Duff has been named Director, Public Affairs at NASA Headquarters. The appointment was effective April 7. Duff brings to NASA more than 17 years of management communications and media services experience, including 10 years of government public affairs experience. He had been Managing Director, Public Affairs at Amtrak in Washington, D.C., where he supervised the headquarters public affairs staff and three field offices. Earlier, he served two years as Deputy Assistant Secretary for Public Affairs at the Department of Health, Education and Welfare.

Previously, Duff was employed by NASA at the Johnson Space Center, Houston, where he directed the full range of public affairs activities during a period of intense manned space flight activity, including five lunar flights and the first manned landing on the Moon. Duff also spent five years as NASA Headquarters Director of the Special Events Division, where he was responsible for a wide variety of public affairs activities.

In 1969 Duff was Vice President for Communications of the National Urban Coalition, where he established the department of communications for the new national public service organization.

As NASA Director, Public Affairs, Duff will be responsible for agencywide activities involving the general public, the news media and the educational community. He reports to the Associate Administrator for External Relations and serves as a principal advisor to the Administrator and Deputy Administrator. He received his degree from the University of Michigan.

Ballhaus Heads Major NASA Unit

Dr. William F. Ballhaus, former member of the Aeromechanics Laboratory, Army Research & Technology Laboratories (AVRADCOM) and former Chief, Applied Computational Aerodynamics Branch, NASA Ames Research Center, has been named Director of Astronautics at Ames, at 35 one of the youngest men ever to hold that position. The Astronautics Directorate, one of five major Directorates at Ames, is responsible for Airborne Missions and Applications Division, Project Pioneer, Space Project Division, Space Science Division and the Thermo-and Gas-Dynamics Division.

Ballhaus has been with the Aeromechanics Laboratory since 1971 when he received his Ph.D from the University of California at Berkeley. As Chief of the Computational Aerodynamics Branch, he was the first Army research scientist to head a NASA research branch.

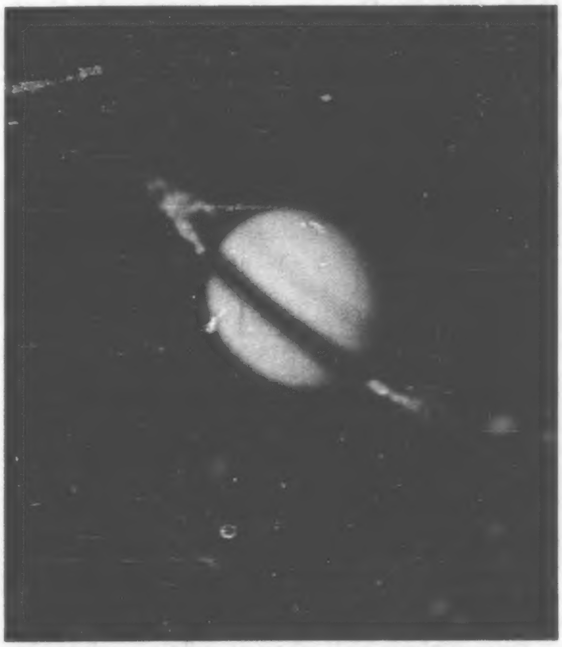
The author of more than 30 technical papers on computational aerodynamics, he was co-recipient of the prestigious H. Julian Allen Award in 1977, a Special Act Award in 1979, including a check for $1,000 "for advancing computational fluid dynamic methods as a practical tool for improving designs of transonic aircraft . . .", and the coveted Lawrence Sperry Award for 1980, presented by the American Institute of Aeronautics & Astronautics.

NASA General Counsel Honored

S. Neil Hosenball, General Counsel for the National Aeronautics and Space Administration is one of 10 winners of the National Civil Service League Career Service Awards for 1979–80.

Hosenball, who was named to his present position in June 1975, was cited in his nomination as having been "instrumental in shaping NASA's legal and management policies from the agency's earliest years."

A native of New York City, Hosenball received a Bachelor of Science degree in 1948 from the University of Michigan and his LL.B. degree from



Newest Saturn Release—This photograph of Saturn was issued after computer enhancement brought out the rings and other features. It was taken by Voyager 1 on March 20, 1980, at a distance of 312,270,000 kilometers. One of Saturn's moons, Rhea, can be seen at lower left. Voyager 1 will make its closest approach to Saturn on November 12, 1980 while the sister craft, Voyager 2, will fly past in August, 1981. The project is directed by the Jet Propulsion Laboratory.

Harvard Law School in 1951. He is a member of the Ohio and Florida Bars and is admitted to practice before the U.S. Supreme Court.

After a time in private law practice, in 1961 he became Chief Counsel at NASA's Lewis Research Center in Cleveland. In 1966 he came to NASA Headquarters in Washington as Assistant General Counsel for Procurement Matters and the following year was named Deputy General Counsel.

Hosenball is a member of the Administrative Conference of the United States and is active in the work of the Legal Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space. He is a frequent writer and lecturer on space law, administrative law, procurement law and related subjects. In 1967 he was awarded the NASA Exceptional Service Medal and the NASA Distinguished Service Medal in 1973.

He and his wife, the former Rosalyn Green, make their home in Washington, D.C. They have three children.

NASA Selects Gamma Ray Contractors

Two companies have been selected for negotiation of contracts to perform Phase I concept design studies for the Gamma Ray Observatory space astronomy mission. The companies are the General Electric Co., Space Division, Valley Forge, Pa., and the TRW, Inc., Space Systems Group, Redondo Beach, Calif.

The studies are to be completed in six months at a cost of about $500,000 each. It is planned that one of these contractors will be selected to build and operate the satellite under a separate, follow-on contract after the mission receives Congressional approval for development.

The observatory, weighing more than 11,000 kilograms is expected to carry five large gamma-ray instruments requiring sustained pointing at gamma ray sources in space. The spacecraft system will provide attitude control, power and command-communications systems to support the scientific instruments.

Gamma rays are one of three kinds of radiation emitted by radioactive substances, and their ability to penetrate matter is high. Their energies range from 5 to 13 electron volts. The rays are produced in many ways. One way is that cosmic rays interact with gases, dust and magnetic fields that exist between stars, producing gamma radiation. The gamma rays can therefore be used to trace and map the distribution of cosmic rays and gas in the galaxy.

Two Decades of Delta—In a ceremony at the Goddard Space Flight Center, Goddard Director A. Thomas Young (left) accepts a National Space Club Special Award from Space Club President John Lent as NASA Deputy Administrator Dr. Alan Lovelace approves. The award and others honored Goddard management of the Delta launch vehicle, after the workhorse rocket compiled its 150th successful operation since 1960.

Until the 1940's, virtually all astronomical knowledge was derived from the very narrow portion of the electro-magnetic spectrum called the "optical window," the range of frequencies to which our eyes are sensitive. After World War II, largely as a result of technical developments in the radar field, radio astronomy emerged. With the advent of orbiting satellites, the X-ray portion and then the infrared portions of the electromagnetic spectrum came under study by space vehicles. Gamma ray astronomy is providing fundamentally new information about stars, the galaxy and the universe.

The GRO is planned to be launched aboard the Space Shuttle in the mid-1980s, and to be capable of being retrieved at a later time. The GRO expected mission life is about two years.

The project will be managed by the Goddard Space Flight Center, under direction of NASA's Office of Space Science.

Materials Processing in Space Reviews

A series of comprehensive scientific reviews covering all of NASA's ground-based and flight experiment work in the field of materials processing in space (MPS) is underway at the Marshall Space Flight Center.

Marshall is sponsoring the reviews on behalf of Dr. John R. Carruthers, Director, MPS Division, Office of Space and Terrestrial Applications, NASA Headquarters. Dr. Carruthers is expected to attend all of the planned reviews. Lowell Zoller, manager of the Marshall Center's Materials Processing in Space Projects Office, said the reviews "will provide a measure of the continuity and coherence which is needed among the many university, industrial and government researchers as this scientific effort matures." The meetings will be annual events, he said, with one series in the spring and another in the fall.

Marshall center investigators participating include Dr. Mary Helen Johnston, Dr. Lou Lacy, Dr. William Oran, Dr. Mirt Davidson and Dr. Robert Snyder. Attendance of approximately 50 persons, from throughout the U.S. is anticipated for each review. Topics for the reviews cover the general field of crystal growth processes, material solidification processes, containerless processing and fluid dynamics.

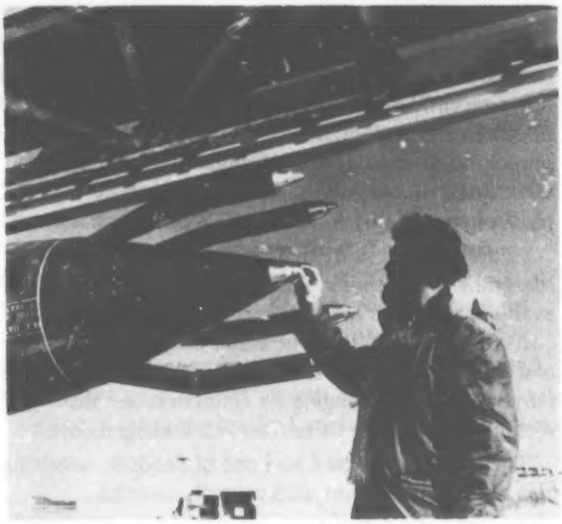
Teleoperator Maneuvering System

NASA has asked the aerospace industry for proposals on a study of mission requirements and systems definition for a teleoperator maneuvering system for the Space Shuttle.

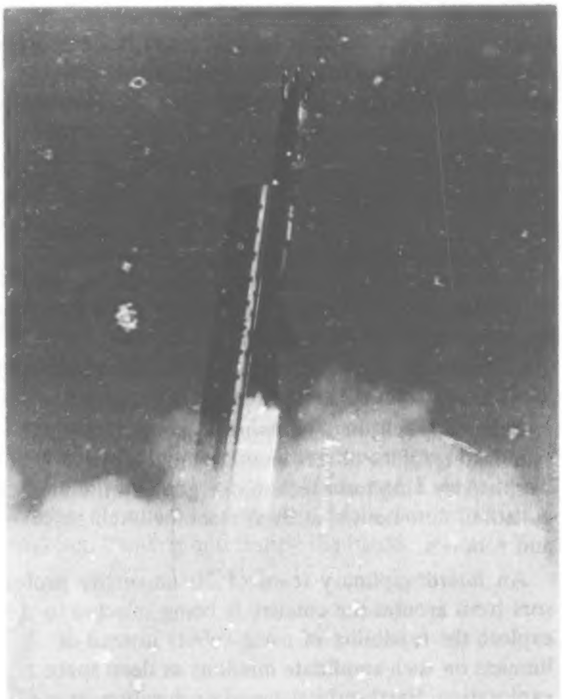
The project involves the development of a versatile remotely-controlled propulsive stage "mini-tug" vehicle for providing a wide range of payload placement, retrieval, servicing, and assembly support functions in Earth orbit.

The request for proposals was issued by the Marshall center. A task team in Marshall's Program Development Directorate will manage the studies.

Development of an earlier version, called teleoperator retrieval system had been initiated by NASA in October, 1977, as part of an effort to re-boost the falling Skylab Orbital Workshop. That Skylab-related project was later terminated, however. NASA is now looking at an updated, more capable teleoperator maneuvering system.



Multiple Threat at Wallops—A curious-looking, hydra-headed rocket was mounted and launched from Pad 2 at the Wallops Flight Center in February. Despite the unusual payload, the booster was identified as an "old reliable" Honest John, one of many used at Wallops over the years. The five-arm payload configuration is part of a new electronic time fuze for the Department of the Army's multiple launch rocket system and is being developed by the Harry Diamond Laboratories near Washington. Plans are for the new fuze to be employed by NATO forces in a field artillery system of self-reloading pods.



F–104 Flight Extends Low-G Time

A low-gravity materials processing experiment was flown recently on a NASA F-104 aircraft at Dryden Flight Research Center, and an analysis of data and photographs taken during the flight shows that up to 60 seconds of low gravity can be obtained during each parabola—twice the time of a KC-135 parabola.

"This means," said Richard Poorman of the Materials Processing in Space Project, "that we can evaluate proposed low-g experiments at a very low cost prior to flying them in much more sophisticated and expensive payloads. We can use the F-104 for this purpose without changing its configuration and without interrupting its normal work assignments."

The experiment flown was one of dendrite remelting and macro segregation with several scientific objectives. The experiment apparatus was developed at Marshall center and the principal investigator is Dr. Mary Helen Johnston.

Since the experiment is one that had already been flown on Space Processing Applications Rocket, (SPAR) data and photos from the F-104 flight could be compared with those from the previous SPAR flight to assure that the low-g level obtained in the F-104 will be a useful evaluation environment for proposed low-g experiments.

"Analysis of the experiment flown recently," said Poorman, "indicates that the F-104 test bed provides a much-needed intermediate capability, at quite moderate cost, between the limitations of laboratory and drop-tube testing and the substantially more complex and costly flight programs on SPAR and planned Space Shuttle flights."

The Robot Role

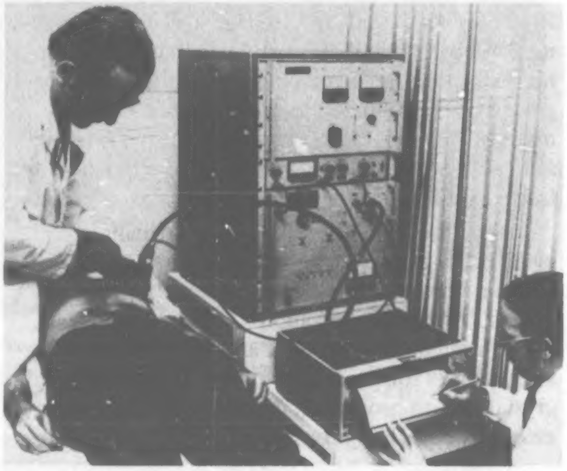
The role that robots could play in future space exploration will be the subject of a 10-week, NASA-sponsored summer study at the University of Santa Clara, June 23 through August 29, 1980.

This study will be an important contribution to establishing Office of Aeronautics and Space Technology long-term technology goals in the area of advanced automation, such as machine intelligence and robotics.

An interdisciplinary team of 20 university professors from around the country is being selected to explore the feasibility of using robots instead of humans on such candidate missions as deep space exploration, Earth-orbital-based exploration, space utilization, Earth-orbital launch and support operations, and aeronautical systems.

Academic participants are being selected through a joint NASA Office of University Affairs and American Association of Engineering Education program. Dr. Timothy Healy of the University of Santa Clara and J. E. Long of the Jet Propulsion Laboratory are codirectors of the study.

This study will follow and utilize the results of a one-week advanced automation goals symposium, chaired by Dr. Robert Cannon of Stanford University.



NASA Steps to Combat Cancer—Dr. Anas El Mahdi (left) and Dr. James Shaeffer of Norfolk General Hospital in Virginia use a microwave applicator to detect a possible tumor in a patient. Developed through research at Langley Research Center, the instrument uses aerospace technology to discover cancerous human tissue. In Houston, the Johnson Space Center is supporting St. Joseph's Hospital in its work with heat, or hyperthermia, treatment of cancer.

Contractor News

Serv-Air, Inc., of Greenville, Tex., has been selected for final negotiations of a contract for the operation, maintenance and repair of NASA Dryden Flight Research Center facilities at Edwards, Cal. A one year contract with two one-year options is under contemplation. The basic year is estimated to cost in the vicinity of one million dollars with an approximate total of $3.4 million for the three-year period.

Planning Research Corporation's Data Services Company, of McLean, Va., has been awarded a contract to provide automatic data processing services for Goddard Space Flight Center's Management Systems Office. The contractor's estimated cost of the cost-plus-award-fee contract is $4 million plus for a base period of one year, with three additional one-year optional extensions. The office is responsible for all administrative automatic data processing functions at Goddard and the services include consultation, systems development, production computer processing and customized technical support.

ACL-FILCO Corporation, of 3333 W. Warner Avenue, Santa Ana, Cal., has won a contract with NASA to manufacture hydraulic control units for use in the Space Shuttle program. The firm fixed price contract is for a total of over $1 million. Under its provisions, ACL-FILCO will manufacture 10 hydraulic control units to be employed as ground support equipment, with three of the units installed in Bay 2 of the Orbiter Processing Facility at the Kennedy Space Center and the remaining seven used in Mobile Launch Platform Number 2. They will test the hydraulic systems of both the Space Shuttle orbiter and its two solid rocket motors before launch.

The Hampton Technical Center, a division of Kentron International, Inc., of Dallas, has received a contract modification from NASA for 10 Algol 111A Scout rocket motors. The modification is valued at approximately $2.2 million and will be effective through March 31, 1981. Scout is NASA's smallest launch vehicle, a four-stage, solid propellant rocket used to launch many kinds of payloads for DoD and several foreign countries as well as NASA. The Scout program is managed by the Langley Research Center.

Did You Know?

NASA 6 is a Beechcraft D-18, a twin engine plane used by the Computer Sciences Corp. at the Kennedy center to measure the winter freeze line in Florida. When 32-degree temperatures arrive in Florida, CSC technicians Jon Reneau and Keith Todd take off from Patrick Air Force Base on their freeze finding missions. Data from an infra-red multispectral scanning system mounted in the NASA 6 aircraft is relayed to the University of Florida, which has been making a freeze line study since 1972. The University uses the scanner information in conjunction with satellite data; the result will be a computer model of Florida winter weather expectations providing highly accurate freeze forecasts to citrus growers.

Health Clinic at the Johnson Space Center has been recognized by Idea Clearinghouse for developing a more efficient and economical technique for processing blood samples taken during physical examinations. Lab supervisor Jerry Terrell learned of the technique, using the Gifford System 5 chemistry analyzer, at a convention of medical technologies in Denver. Cholesterol, triglyceride, uric acid and SGOT levels in the blood are tested during examinations. With the new system, and Terrell's development of micro procedures (using less reagent), there has been a 79 percent decrease in the total cost of blood sample processing over previous methods.

"Planet Mars", the NASA motion picture available to all centers for viewing, has been awarded the Bronze Plaque in the Scientific Research Category at the 11th International "Nikola Tesla" Festival of Scientific and Technical Films, 1980, at Belgrade, Yugoslavia.

Two firms of the **NASA/DoE/industry wind turbine generator team,** Structural Composites, Inc., and Kaman Aerospace Corp., won Materials Engineering Magazine awards for the best use of materials and materials fabrication processes in product design and manufacture. Structural Composites received the Grand Award for developing a filament winding process to produce a composite spar for a wind turbine rotor blade and Kaman Aerospace earned an Award of Merit for its part in designing, building and testing the blade.

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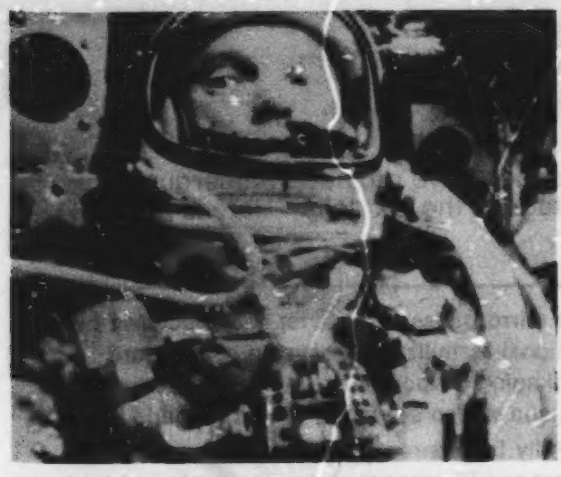
Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

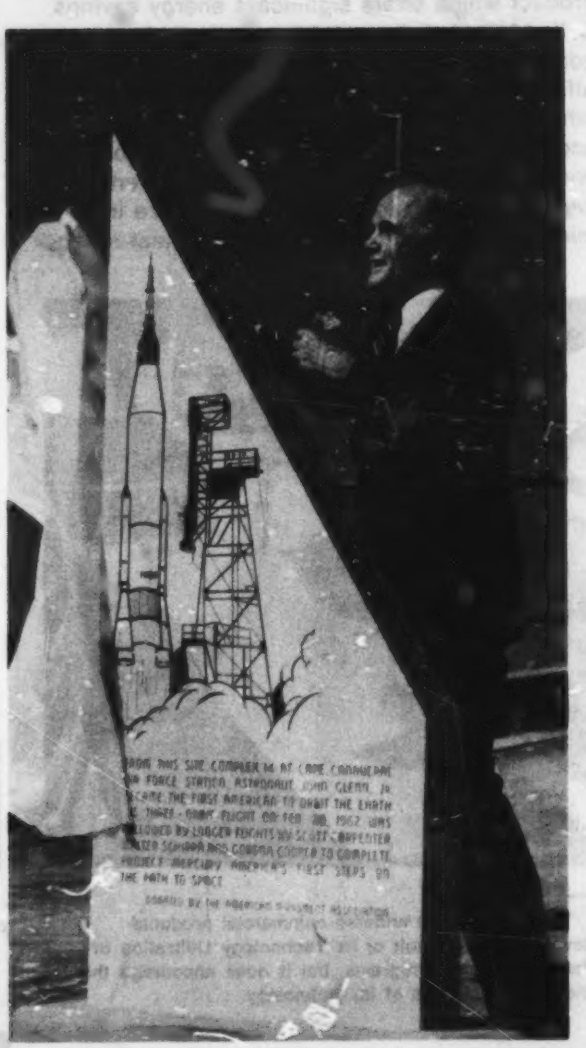
Inventor(s) & Employer	Title	Patent No.	Installation
John W. Kaufman, NASA/Marshall	Wind wheel electric power generator	4,191,505	MSFC
Ronald N. Jensen, NASA/Langley	Combined solar collector and energy storage system	4,192,290	LaRC
Jose D. Giner, Kathleen J. Cahill Giner, Inc., Waltham, Mass.	Catalyst surfaces for chromous/chromic redox couple	4,192,910	LeRC
Sidney O. Kastner, NASA/Goddard	Diffractoid grating configuration for X-ray and ultraviolet focusing	4,192,994 3–10	GSFC
Henry C. Hoffman, James H. Donohue NASA/Goddard	Active nutation controller	4,193,570	GSFC
John A. Woollam, NASA/Lewis	Atomic hydrogen storage method and apparatus	4,193,827	LeRC
Demetrius A. Kourtides John A. Parker, NASA/Ames	Low density bismaleimide carbon microballon composites	4,193,829	ARC
A. Bruce Whitehead Thomas A. Tombrello, Caltech/JPL	Method and means for helium/hydrogen ration measurement by alpha scattering	4,194,115	NRO/JPL
Earl R. Collins, Caltech/JPL	Improved system for slicing silicon wafers	4,191,159	NRO/JPL
David C. Grana Richart T. Wilem, NASA/Langley	Kine-Pak-A self-contained electrical power generator system	4,191,893	LaRC
Lien C. Yang, Caltech/JPL	Portable heatable container	4,193,388	NRO/JPL
James F. Charles Harry Theakston, Rockwell Int. Space Systems Group Downey, Calif.	Floating nut retention system	4,193,435	JSC
Joseph S. Heyman, NASA/Langley	Solid state phase insensitive ultrasonic transducer	4,195,244	
Meyer M. Lemcoe Harry E. Pattee Battelle Lab., Columbus, O.	Attaching of strain gages to substrates	4,195,279	DFRC
Rodolf A. Schindler, Caltech/JPL	Improved velocity servor for continuous scan interferometer	4,193,693	NRO/JPL

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January 17	Atlas Centaur	ETR	DOD Navy. Reimbursable
SMM-A	February 14	Delta	ETR	NASA. Scientific Solar Maximum Mission.
NOAA-B	May	Atlas-F	WTR	NOAA Weather. Reimbursable.
Navy-20	July	Scout	WTR	DOD Transit. Reimbursable.
GOES-D	August	Delta	ETR	NOAA Weather. Reimbursable.
Intelsat V-A	September	Atlas Centaur	ETR	Intelsat communications. Reimbursable.
Navy-21	October	Scout	ETR	DOD Transit. Reimbursable.
SBS-A	October	Delta	ETR	Satellite business systems. Reimbursable.
FLTSATCOM-D	November	Atlas Centaur	ETR	DOD Navy. Reimbursable.
Intelsat V-B	December	Atlas Centaur	ETR	Intelsat communications. Reimbursable.



Remembrance at Pad 14—On February 20, 1962, an onboard camera portrayed John Glenn in the midst of his three-orbit mission around the Earth in a tiny Mercury capsule. On the anniversary, 18 years later, Senator Glenn and his wife Annie were greeted by hundreds of aerospace, KSC, Air Force and community people at the dedication of the Mercury Monument at Cape Canaveral. Before unveiling the memorial at Complex 14, the first American to orbit the globe spoke with nostalgia of those pioneering days and cited the new goal of making access to space routine and economical with the Space Shuttle.


ROM THIS SITE COMPLEX 14 AT CAPE CANAVERAL
IR FORCE STATION ASTRONAUT JOHN GLENN JR
ECAME THE FIRST AMERICAN TO ORBIT THE EARTH
THREE-ORBIT FLIGHT ON FEB 20, 1962 WAS
LLOWED BY LONGER FLIGHTS BY SCOTT CARPENTER
LTER SCHIRRA AND GORDON COOPER TO COMPLETE
PROJECT MERCURY AMERICA'S FIRST STEPS ON
THE PATH TO SPACE

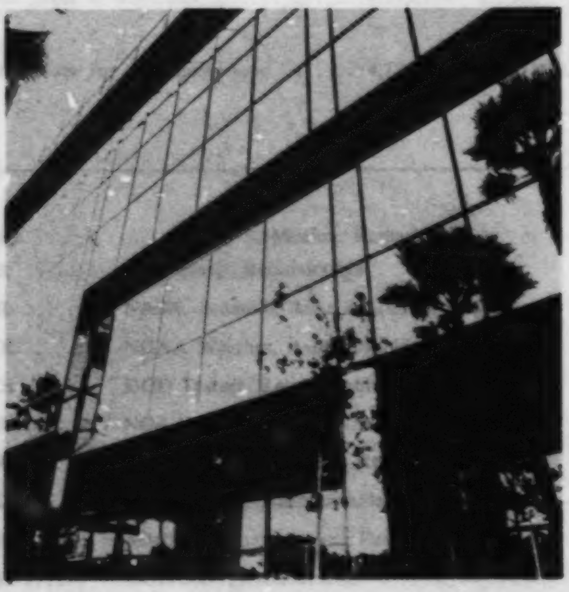
Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Window Film for Warm Days

A highly reflective insulating material developed to protect NASA spacecraft from intense solar radiation is now being used in a commercially-available window insulation product which offers significant energy savings. Called Nunsun*, it is a thinly metallized film adhesively bonded to the windows of homes, office buildings, schools, industrial plants and other facilities. The film reflects the Sun's heat and glare outward, thereby cutting down on the energy cost for cooling. Trained dealer personnel can affix the film to windows of any size in minutes, converting ordinary glass to heat-reflective mirror glass at low cost. Manufactured by National Metallizing, a division of Standard Packaging Corporation, Cranbury, New Jersey, Nunsun is also available in windowshade form.

Fully transparent and easily cleaned, Nunsun filters out 75 percent of the Sun's infrared heat rays which would otherwise penetrate the glass and heat interior space. In summer, the film substantially reduces air conditioning requirements. It affords additional energy savings in winter by blocking the escape of interior heat through glass. Available in color combinations, the film is said to protect draperies, carpets and other furnishings from Sun-fading.



For the benefit of all . . .

NASA
National Aeronautics and
Space Administration

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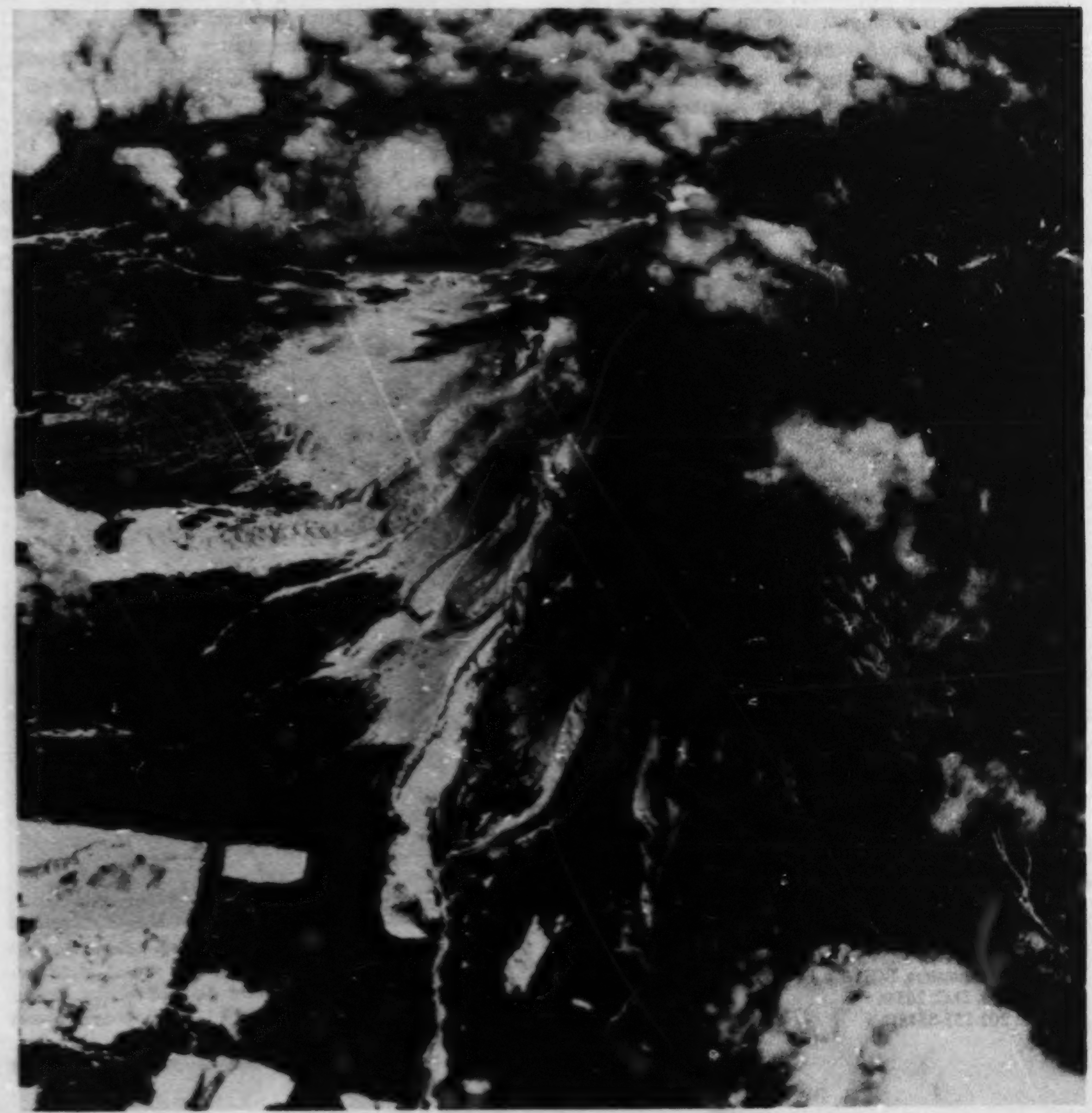

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Cover

Lofty View of Volcano—A NASA/Ames Research Center U-2 aircraft took this oblique view of the erupting Mount Saint Helens in Washington from an altitude of 65,000 feet. The picture was made from the west side of the mountain. To the north, the snow appears white while on the southeastern slope, covered with ash blown by prevailing winds, it looks grey. Tracks along the mountain side are avalanche trails. The U-2 from Ames photographed the volcano with three 24-inch focal length cameras. View was taken prior to the volcano's fierce eruption in mid-May.

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Another Dividend from Air and Space 20

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Shuttle Flight Engines Due Retest

The three Space Shuttle main engines designated for the first flight of the orbiter Columbia will be tested again to assure operational readiness for the flight. The engines, acceptance-tested between April and July 1979, are being shipped from the Kennedy Space Center to the NASA testing facility in Mississippi for reacceptance firings.

The process will take two to three months and is expected to have no effect on the timing of the space Shuttle's first flight, now anticipated between November 1980 and March 1981.

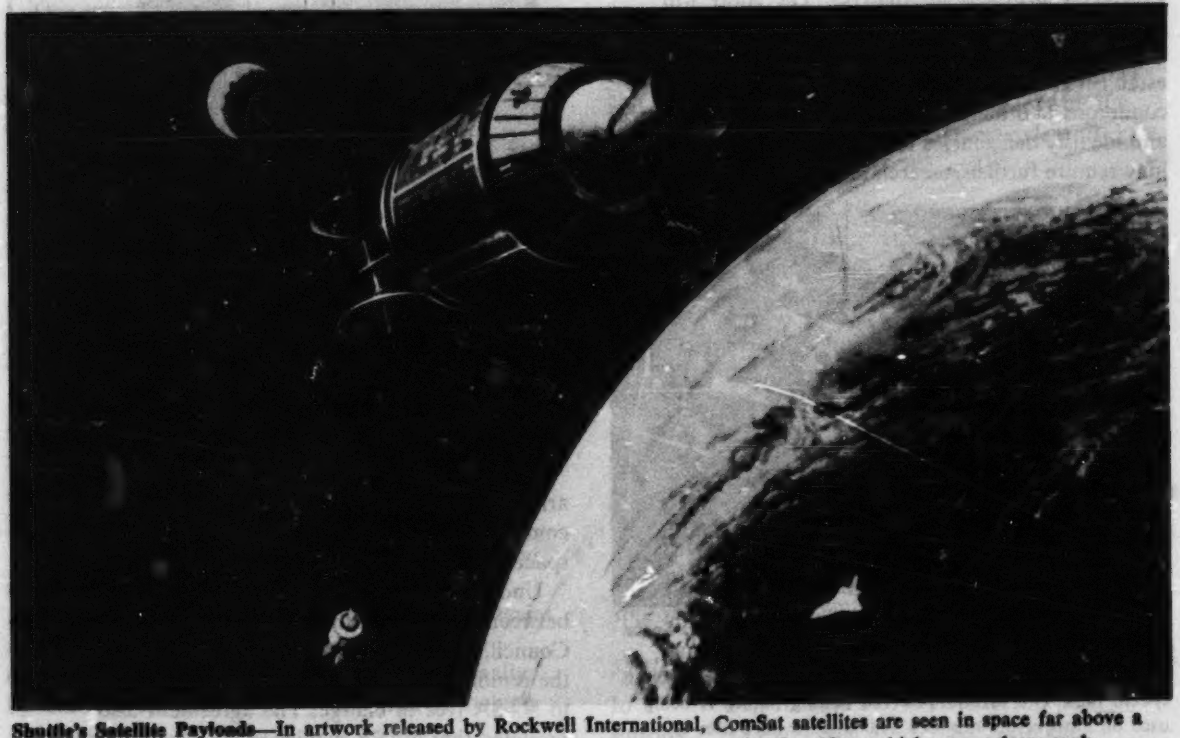
The decision to retest the engines was based on the number of modifications that have been made during the past year. These concerned high pressure turbopumps, valves and nozzles.

Each engine will be operated on the test stands at the National Space Technology Laboratories, Bay St. Louis, Miss. After the trials, the engines will be returned to Kennedy for installation in the Columbia. About six weeks before the first flight, the engines will be fired once again, for 20 seconds, on the launch pad.

Earlier, the third static test of a Space Shuttle main engine was completed in April, and described as "highly successful" by officials at NSTL. This was the final in a series of tests with simulated power levels necessary for an "abort to orbit" during a Shuttle launch.

The engine (No. 2004) was fired for 10 minutes and 10 seconds, with six minutes of the test at the 109 percent power level. This engine has now completed a total of 12,911 seconds (3.58 hours) firing time, equivalent to about 25 flights of the Space Shuttle.

A planned 10-minute test of the Space Shuttle's main engine cluster terminated automatically after about six seconds in mid-April. Probable cause of the shutdown has been identified as a discharge overtemperature on the high pressure fuel turbopump of engine No. 2 of the three-engine cluster. There was no apparent damage to the engines or test stand.



Shuttle's Satellite Payloads—In artwork released by Rockwell International, ComSat satellites are seen in space far above a tiny Space Shuttle orbiter figure circling the Earth. When they become operational, orbiter vehicles can release such communications payloads from their cargo bays. Apogee kick motors attached to the satellites will thrust them into higher, geosynchronous orbits.

Orbiter Thermal Shield Explored

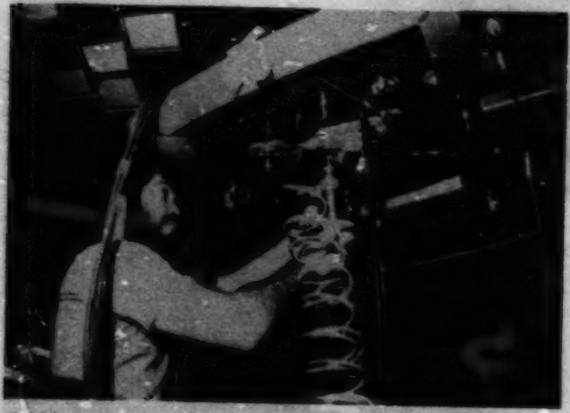
The space agency is requesting proposals from private industry for a design study of alternate thermal protection systems for the Space Shuttle orbiter. The study's results will not affect present orbiter vehicles, but promising alternative systems will be considered for later application.

Proposals for the nine-month assessment were due one month ago and the study should begin in late June. It will be managed by the Langley center.

Major goals of the study are to reduce the costs of the orbiter's thermal protection system and to determine the best available system, whether it is the present one or an alternate one.

The present ceramic system was selected in the early 1970s as the best then available. No detailed assessment of alternate systems has been conducted since that time, however. The new study will bring into focus any recent technological advances in reusable surface insulation.

The study will include evaluation of such types of thermal protection systems as metallic and reinforced carbon/carbon concepts, which are considered probable alternatives. The study will assess potential benefits and problems that might result from alternate thermal protection concepts; establish guidelines to cope with varied loading conditions and handling, inspection and maintenance; and identify deficiencies in present technology that may require further research and development.



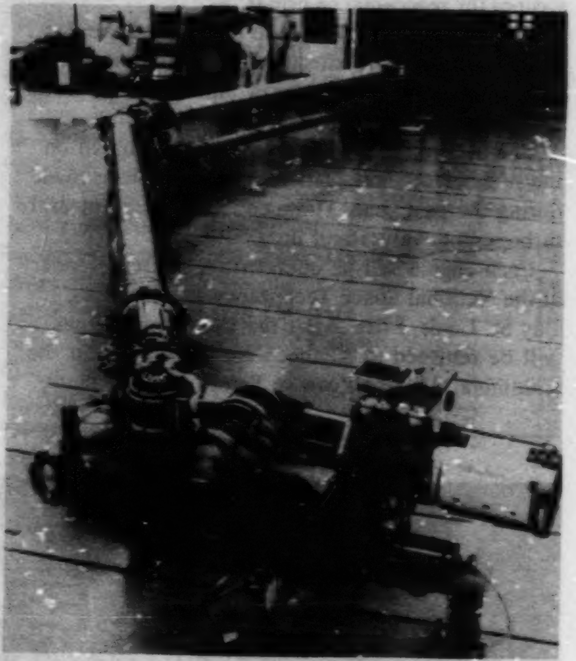
Tugging at Orbiter Tile—A technician at the Kennedy Space Center, working under the belly of the orbiter Columbia, adjusts his device to proof test individual thermal protection system tiles. The vacuum-powered pulling fixture is being used on most of the orbiter's 31,000 silica fiber tiles to verify their ability to withstand repeated launch and reentry stress. NASA is considering a study of alternate thermal protection systems for future Space Shuttles.

NASA Contract for Shuttle Manipulators

The Johnson Space Center has signed a contract with Canadian Commercial Corp. of Hull, Quebec, covering production of three remote manipulator systems for the Space Shuttle orbiter. Valued at $63,640,000, the cost-plus-fixed-fee contract will be 100 percent subcontracted to Spar Aerospace Ltd. of Toronto, Ontario. The contract formalizes a NASA letter contract issued May 1, 1979.

The remote manipulator system is a long, jointed arm operable from within the orbiter's crew compartment to deploy or retrieve payloads in space. The arm is 15.2 meters long.

Under a 1975 memorandum of understanding between NASA and the Canadian National Research Council, Canada developed the first flight unit of the remote manipulator system and will provide it to NASA free of charge. The agreement also provided that NASA would procure from Canada additional systems as required to support NASA programs.



Long Arm of Shuttle—The flight article of the first Space Shuttle remote manipulator system arm lies on the air bearing floor of the Spar Aerospace facility in Toronto, Ontario, Canada. The complimentary robot arm was provided by Canada under a 1975 agreement and NASA has now contracted for three more remote manipulators for use on the Shuttle orbiter.

Testing Seniors for Stresses

Can humans older than 55 withstand the physiological stress of weightlessness riding aboard Space Shuttle? To answer that question, the space agency for the first time is subjecting males aged 55 to 65 to prolonged bedrest, a way to simulate the weightless environment of space flight.

The test subjects are the oldest people to undergo simulated weightlessness at NASA. Four previous studies at Ames Research Center tested males and females aged 35 to 45 and 45 to 55.

Forty-six males, aged 55 to 65, reported for the first briefing at Ames in early February. Of the 44 who reported for physical examination, 25 were found fit enough to participate in preliminary testing—10 of these were in the 60-65 age group. Twenty were selected to report for orientation with the other five serving as alternates.

The preliminary orientation and testing serves a dual purpose: It gives Dr. Harold Sandler, Ames project scientist, an opportunity to see how subjects perform and it also allows the subjects an opportunity to decide whether they want to participate.

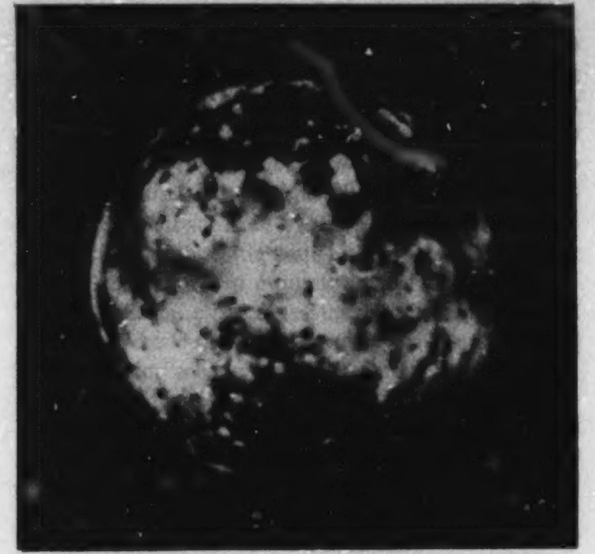
Two sets of four subjects were admitted to Ames' human research facility for nine days of controlled observations, 10 days of bedrest and five days of recovery and post-bedrest tests of the cardiovascular system.

According to co-investigator Dr. Danielle Goldwater, preliminary indications are that healthy men in that age group would be able to participate in future Shuttle flights.

Jovian Moons Being Mapped

A major step in accurately mapping Jupiter's four large moons has been completed by Merton E. Davies of Rand Corp., Santa Monica, Calif., and several colleagues, based on photographs from NASA's Voyager spacecraft.

Using many of the 33,000 pictures of Jupiter and its Galilean satellites taken by Voyager 1 in March 1979 and by Voyager 2 in July 1979, Davies and his colleagues have put together geodetic control networks that will be used internationally by astronomers and planetary scientists in making and using maps of the bodies.



Moon of Jupiter—Taken from 2.6 million kilometers, the Jovian moon Io is large enough to be a planet in itself. Along with Jupiter's three other large moons, Io is being mapped by the Rand Corporation using Voyager pictures.

Geodetic control networks are used to compute geographic coordinates of features on the surface. They are also used to determine latitudes and longitudes for preparation of maps.

In addition to the new control networks, Davies and his colleagues accurately established radii of the four satellites—Io, Europa, Ganymede and Callisto. Those radii are:

- Io = 1,816 ± 5 kilometers
- Europa = 1,563 ± 10 km
- Ganymede = 2,638 ± 10 km
- Callisto = 2,410 ± 10 km

Control networks for the satellites contain: Io, 307 points, 159 pictures; Europa, 86 points, 46 pictures; Ganymede, 227 points, 71 pictures; Callisto, 291 points, 95 pictures. The control networks and resulting maps will help astronomers and planetary scientists to maintain an accuracy never before possible.

Voyager's narrow-angle camera gives a 1 km resolution from a distance of 50,000 km. Closest approaches to the satellites were as follows:

Satellite	*Voyager 1 Distance*	*Voyager 2 Distance*
Io	20,570 km	1,129,900 km
Europa	733,760 km	205,720 km
Ganymede	144,710 km	62,130 km
Callisto	126,400 km	214,930 km

The Jet Propulsion Laboratory in Pasadena, Calif., the government-owned facility operated for NASA by the California Institute of Technology, manages the Voyager project for NASA's Office of Space Science. The two Voyagers are now enroute to encounters with Saturn. Voyager 1 will arrive in November 1980; Voyager 2 will arrive in August 1981.

Large Space Antenna Study

Marshall Space Flight Center has received proposals from several companies interested in defining a space flight experiment that would demonstrate, in low Earth orbit, the characteristics and performance capabilities of a large space antenna system. Such a large system, if put into wide future use, could significantly change communications, radar and radiometry operations from satellites.

The Marshall center plans to select two companies to conduct parallel 12-month definition studies. Large antenna systems may be the answer to many problems that now prohibit expansion of satellite communications, Earth resources surveys, weather research and other services. Dozens of smaller satellites, each with its own antenna, now provide such services. The growing number of these independent satelites is rapidly depleting available transmission frequencies, requiring more and more ground receiving stations, and filling up available space in required geosynchronous orbits over the Earth's equatorial region.

As a step toward the use of large space antenna systems, the Marshall center plans a large experimental antenna that could be flown in low Earth orbit for test and demonstration purposes. This demonstration, to be defined under the study contracts announced, would verify the antenna's structural integrity and test methods of packaging, transportation and orbital deployment.

Presidential Good Wishes

In January, the National Aeronautics and Space Administration was recognized for its efforts in implementing the Civil Service Reform Act of 1978 and given the new award sponsored by Reps. Morris K. Udall and Edward J. Derwinski. Last April 11, NASA Administrator Dr. Robert A. Frosch received the following letter from the White House:

To Bob Frosch

I want to congratulate the National Aeronautics and Space Administration on receiving the first Udall/Derwinski Award for excellence in civil service reform implementation. Civil service reform is the most effective method we have for bringing better management and increased productivity to the Federal Government, and my sincere thanks go to the men and women of your agency for the exemplary role they have played in making that reform a reality.

The leadership and professionalism demonstrated by NASA in establishing its Senior Executive Service and in designing and administering performance appraisal systems are helping to ensure the success of such programs throughout Government. My congratulations on a job well done.

Sincerely,
Jimmy Carter

Smylie to Head Tracking and Data

Robert E. Smylie, Deputy Director of Goddard Space Flight Center has been named Associate Administrator for Space Tracking and Data Systems at NASA Headquarters effective April 20.

In his new position, Smylie will be responsible for planning, development and operation of global tracking networks, facilities and systems for communications and data acquisition and processing for all space flight programs.

He became Deputy Director of Goddard in December 1976 and was Acting Director June 1979 to February 1980.

Prior to that he was Acting Associate Administrator for Aeronautics and Space Technology at NASA Headquarters, July–December 1976 and Deputy Associate Administrator for Aeronautics and Space Technology from October 1973 to July 1976.

From 1962 to 1972, Smylie was assigned to Johnson Space Center, Houston, where he was

Chief, crew systems division; Assistant Chief for Apollo support, crew systems division; Chief, Apollo support office; and Head, environmental control systems branch, life systems division. In these positions, he was responsible for activities in support of the Apollo and Skylab programs. He was U.S. chairman of the working group concerned with crew transfer and life support systems for the Apollo Soyuz Test Project.

Before joining NASA in 1962, Smylie was employed by the Douglas Aircraft Co., Santa Monica, Calif., where he was responsible for various systems in the development of the DC-8 aircraft. Upon completion of the DC-8 program, he led a research group concerned with air conditioning problems associated with the supersonic transport and subsequently was assigned as lead engineer for the Skybolt missile thermal conditioning systems.

Smylie graduated from Mississippi State University and received a master's degree in mechanical engineering. He completed the requirements for a master's degree in management as a Sloan Fellow at Massachusetts Institute of Technology in 1967. In addition, he has done graduate work at the University of California, Los Angeles.

He has received the NASA Exceptional Service Medal, and the Victor Prather Award as well as various Johnson center awards. He is an Associate Fellow of the American Institute of Aeronautics and Astronautics and a Fellow of the American Astronautical Society.

Smylie, his wife June. and three children reside in Clinton, Md.

Options for Landsat-D Program

The Space Agency is studying options to restructure its Landsat-D project because of increasing engineering and managerial problems encountered in the manufacture of the spacecraft's instrument and ground systems.

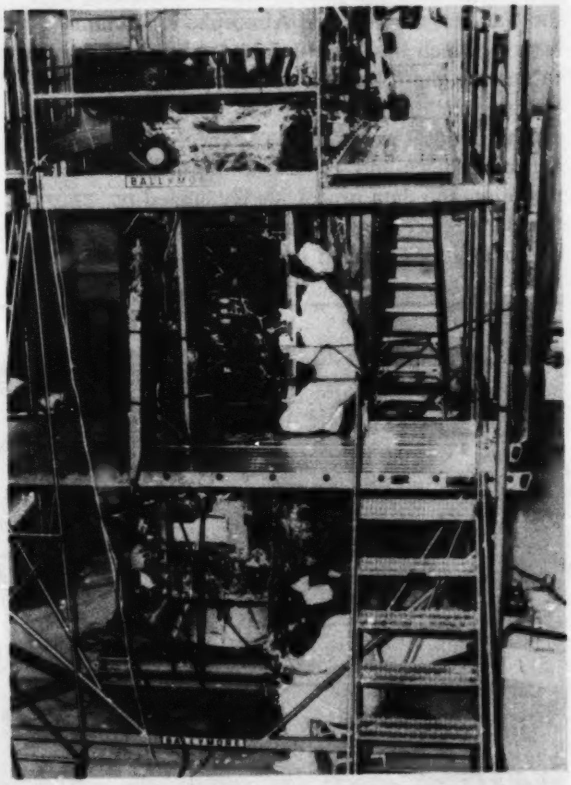
Landsat-D is the fourth, and most technologically advanced, spacecraft in a series of experimental Earth resources monitoring satellites to be developed by NASA. Although designed with a one-year lifespan, each of the first two Landsats, launched in 1972 and 1975, respectively, stayed in orbit and sent back data for five years.

Landsat 3, launched in March of 1978 with a designed lifespan of one year, is still operating but has experienced problems with its sensing device called a multispectral scanner, which collects data to be converted to images of Earth's natural resources.

Landsat-D has been designed to carry an advanced scanning device called a thematic mapper which should define Earth imagery in more spectral bands and with twice the resolution (30 meters) of the multispectral scanners of the earlier Landsats.

Problems encountered by the Hughes Aircraft Co. in building the thematic mapper have resulted in sharply increased cost estimates and delivery delays. In addition, the mission system contractor, the General Electric Co., also is experiencing problems and projecting schedule delays resulting in greater anticipated costs for development of both the flight and ground systems it is building for Landsat-D.

Both problems impact the current Landsat-D



Preparing NOAA-B's Debut—Surrounded by three stories of scaffolding, the latest NOAA weather satellite undergoes final testing at RCA Astro-Electronics in Princeton, N.J. The satellite, becoming NOAA 7 on achieving orbit, will provide detailed information for the nation's weather forecasts. Operated by the National Oceanic and Atmospheric Administration, the weather satellites are under NASA management for procurement and launching.

launch schedule, thus increase the risk of creating a gap in the flow of Landsat data to the users.

The three options being considered by NASA officials that keep in mind current budget constraints and yet provide Landsat-D capability as soon as possible are:

- Launch Landsat-D at the earliest possible time, carrying a thematic mapper and a multispectral scanner;
- Launch Landsat-D with only a multispectral scanner as quickly as possible to be followed as soon as possible with another Landsat equipped with a thematic mapper and a multispectral scanner;
- Launch Landsat-D and Landsat-D Prime (backup), each with only a multispectral scanner.

In making its analyses, NASA is consulting with the National Oceanic and Atmospheric Administration, which has been designated by the President to manage the follow-on operational Earth remote sensing satellite system.

The Landsat program is managed by NASA's Office of Space and Terrestrial Applications. Signal reception and data processing is handled by Goddard Space Flight Center, Greenbelt, Md., which exercises mission operations control.

NASA, SBA Sign Agreement

The National Aeronautics and Space Administration has signed an agreement with the Small Business Administration to participate in a special cooperative program to help develop small business concerns owned and controlled by socially and economically disadvantaged individuals.

The compact is similar to the program spelled out in Section 8(a) of The Small Business Act as amended by Public Law 95–507 and calls for the development of minority firms through contracts and subcontracts to them through both NASA and the SBA.

Under the agreement, signed by NASA Administrator Dr. Robert A. Frosch and Small Business Administrator A. Vernon Weaver, both agencies can identify particular procurement requirements relating to the special program. The NASA Administrator, however, will retain final say in the award of any contracts under this program.

The Small Business Administration has indicated that it will provide management and technical assistance, advance payments, and business development expenses as appropriate to any minority firms awarded contracts under this special agreement.

The cooperative program will run through

Awards Time at Marshall—At a recent ceremony in Huntsville, Dr. Robert A. Frosch presented awards to the Marshall center personnel responsible for the three-mission High Energy Astronomy Observatory program success story. From the left, Dr. W. R. Lucas, Marshall Center Director; the NASA Administrator, congratulating Dr. Fred A. Speer, who received the NASA Distinguished Sevice Medal for managing the HEAO project; Fred S. Wojtalik, HEAO chief engineer, recipient of the NASA Outstanding Leadership Medal; and Dr. Thomas A. Parnell, HEAO 3 project scientist, who was awarded the NASA Exceptional Scientific Achievement Medal. In all, thirty-three Marshall employees were presented individual awards and 78 were honored for their part in team efforts.

September this year. The program can be extended beyond that time if both agencies agree in writing.

In addition to participation in the special cooperative program, NASA has also stated that it will exert its best efforts to achieve three different goals in the area of minority and small business contract awards.

The first is to set a goal of $118.5 million for minority business contracts, of which $51 million would be to the Small Business Administration for further subcontracting to individual firms. The second goal is to achieve $369 million in direct contract awards to small businesses (minority awards included). The final goal is to establish a small business subcontract goal of $386 million for work subcontracted from major NASA contractors.

All of these goals are to be achieved in the remainder of the 1980 fiscal year, ending Sept. 30.

Kudos from Without

Dr. M. Patrick McCormick, Head of the aerosol measurements research branch, Instrument Research Division, at the Langley center has been presented the Arthur S. Flemming Award by the Downtown Jaycees of Washington, D.C. Honored as one of 10 outstanding young Federal Government employees of 1979, McCormick received the Flemming award for his achievements in the development of instrumentation and measurement techniques for the analysis of particulate aerosols in the atmosphere.

William J. O'Donnell, Chief of the media services branch in NASA Headquarters Public Affairs was chosen "top U.S. Government public affairs officer for 1979" by the Aviation/Space Writers Association. The award is recognition, in part, for Bill O'Donnell's outstanding job on the Skylab recovery story last year and for his long career in Federal public information. The nomination was supported by a "Who's Who" of national aerospace reporters from newspapers, magazines and television.

Robert L. Pike, Chief of the Personnel Division, Ames Research Center, recently received the Commander's Award for Civilian Service from the U.S. Army Research and Technology Laboratories (AVRADCOM). Pike was cited for his "professional approach, innovative ideas and superior managerial talent in successfully integrating the Army research lab's personnel system into the NASA Ames system during the period March 1979 to March 1980."

David Lorincz, an aerospace technologist (architect) in the Plant Engineering Division, LRC, has been selected to participate in the Rotary Foundation group study exchange program. As recipient of an honor sponsored by Rotary International, Lorincz will spend five weeks in Japan exchanging design methods and construction techniques with Japanese architects, engineers and other professionals. He will also visit various universities.

New Dish at Ames—Technicians are dwarfed by the 11 meter satellite communications antenna recently installed at Mountain View, Cal., which will bring project engineers at the Ames center real time test data from research aircraft flying over the Mojave Desert, some 460 kilometers away. The new system is being used in the initial expansion of the NASA/Army Tilt Rotor Research Aircraft flight envelope. Feedback between the Ames project office, flight controllers and the pilot in the air is by voice circuit.

A Marshall employee searches through the "stacks" of 400,000 hardcopy documents on file.

Handling the Document Explosion

In the NASA world of high technology, the management of information as a resource presents a demand of epic proportions. Documentation of the agency's myriad endeavors and projects is a continuous job, increasingly complicated and always expanding. This month, Idea Clearinghouse of the NASA Headquarters Information Systems Division has cited the Kennedy and Marshall centers for their handling of this functional management responsibility. Both are using technology to counter the technological paperwork.

Lee Roy Hoekenschnieder, Marshall's repository functional manager, said increasing costs of paper and film have mandated the use of improved techniques and technological advances.

To save money and still meet the 10-day turnaround on providing documentation for nearly 3,000 distribution lists, the repository is going to microfilm and microfiche. "If we didn't, it would take a facility twice as large to handle the reproduction, storage and dissemination tasks we have now," Hoekenschnieder said.

"We estimated that the average document is 60 pages and costs about $3.75 to reproduce in hardcopy. Microfiche of the same document costs about 79 cents. Lower postage rates for the less bulky film account for other appreciable savings." According to Hoekenschnieder, almost 50,000 documents were distributed by the repository during the first month of 1980.

KSC, meantime, reduces costs and increases productivity by processing its engineering drawings and documents through a specified center, incorporating microfilm, computer inputs and filing. The process is defined for users through detailed written instructions and preliminary engineering releases are used to speed the flow of data between the designer and the office in the field.

The magnitude of the document task is borne out by the statistics of the Marshall center alone—more than 10 million microfiche cards, 50,000 drawings and 400,000 hardcopy documents are on file there.

NASA Extends Delta Services

A $70,072,000 follow-on fixed price-incentive contract has been issued to the McDonnell Douglas Astronautics Co., Huntington Beach, Calif., for Delta expendable launch vehicle services. The contract calls for continuation for two years of launch services work performed by the company for the past 19 years for Delta including mission peculiar vehicle changes, checkout and launch.

The services will be performed at the McDonnell Douglas plant in Huntington Beach, at the Eastern Space and Missile Center, Fla., and at Vandenberg Air Force Base, Calif.

The Delta has been used to launch 151 weather, communications and scientific satellites, both foreign and domestic, government and commercial, of which 140 were successful launches.

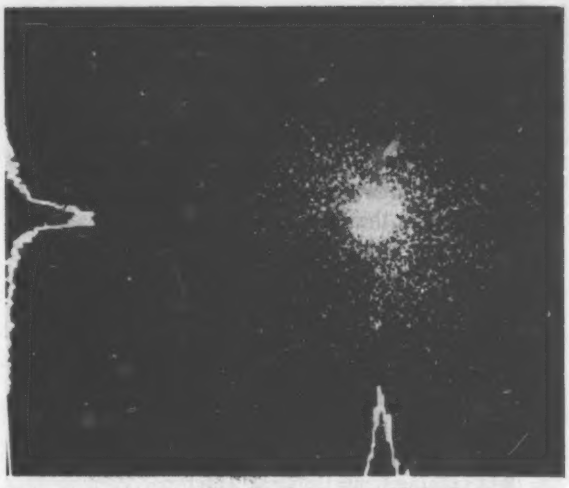
The Kennedy Space Center is responsible for supervision of Delta activities to the Goddard Space Flight Center, which in turn is responsible for overall technical project management of Delta for the NASA Office of Space Transportation Operations, Washington, D.C.

Satellite To Aid Timber Industry

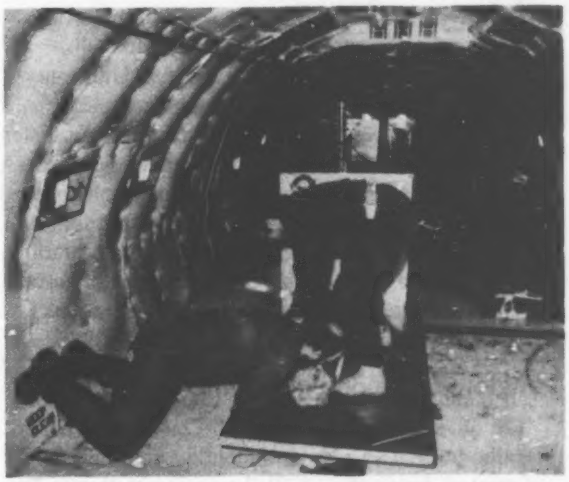
An Earth resources NASA satellite has found a new use: gathering data to improve management of America's forest lands. The project reflects a unique relationship between the government agency and the private sector, one in which the initiating company is sharing the total cost but the technology developed will be available to all other timber companies. The satellite is Landsat 3. The company is the St. Regis Paper Co., New York.

Since 1977, St. Regis has been working with NASA in a test program to see if Landsat data could improve the paper industry's information base on forest lands. The company wants to use the data for planning timber harvests, leasing and buying new timber lands and to monitor more than 920,000 hectares (2.3 million acres) across the South.

The project has been so successful that the St. Regis Southern Timberland Division Jacksonville, Fla., recently authorized over $300,000 of new capital investment for a forest resource information system to use Landsat data to supplement conventionally acquired data in its general operations.



Pulsar According to HEAO—The second High Energy Astronomy Observatory (HEAO 2) continues to send back data of unprecedented detail. In this X-ray image of the Vela supernova remnant, a pulsar emitting radio waves is seen at the center. The Marshall center HEAO, with its computer processing system, is able to record and display the total number of X-ray photons on a scale along the margins of the picture. Astronomers can study the fine details of brightness variations otherwise lost in the X-ray image.



Airborne Resuscitation Drill—Aboard a NASA KC-135 flying out of JSC, the group consists of two paramedics and one mannequin, performing the two person method of cardio pulmonary resuscitation. The medics, working in 30 seconds of zero gravity, are Dr. Joseph Degioanni (standing) and technician Christopher Counts; the mannequin (supine) is Resusci-Annie, an old hand commonly used by the American Heart Association in demonstrations. Both Dr. Degioanni and Annie are wearing the newly developed restraint straps for zero gravity first aid.

The entire forestry industry stands to gain from the venture because technology developed by the St. Regis experiment is in the public domain and available to other companies. The company and NASA plan to conduct a symposium in 1981 to demonstrate Landsat interpretation methods to timber industry managers.

St. Regis was the first private company to act as a user in NASA's resource observation applications test program. The project established a unique relationship between the agency and the private sector, for St. Regis initiated the project—rather than NASA—and the company is sharing in the total cost.

St. Regis will use techniques developed in the project at its Dallas computer facility to process the data coming from Landsat which will complement the automated data base at the St. Regis divisional remote sensing center in Jacksonville. This combined data will assist the company in estimating timber volume and productivity, as well as changes in the conditions of the forests.

Landsat data will be used to determine distribution of the major types of trees on St. Regis-owned timberland in Texas, Florida, Georgia, Alabama, Mississippi and Louisiana and other land available through lease or purchase.

The project is being conducted by Johnson Space Center, Houston; the laboratory for applications of remote sensing at Purdue University in Lafayette, Ind.; and the St. Regis Paper Co. It is scheduled to end in September of this year.

Landsat 3 orbits the globe 14 times a day at an altitude of 900 kilometers. Its electronic multispectral scanner returns data which is processed into film and computer tape format. This resource information may be used to characterize different types of terrain, vegetation, soils, rocks and other surface features.

Langley Environmental Office Meets Goal

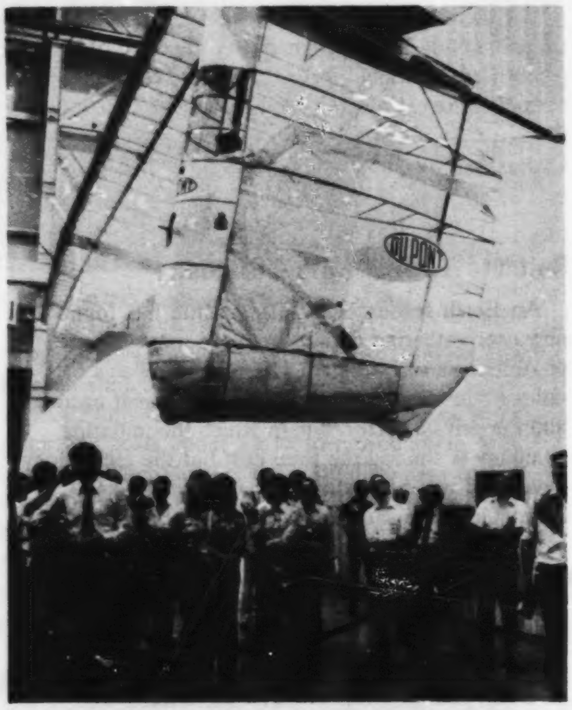
The office at Langley Research Center that literally got NASA's environmental program off the ground during the 1970's has successfully completed its mission and closed its doors.

The Environmental Quality Projects Office was established at Langley in 1972 to lead agency efforts to plan and implement an environmental quality program. With its assignment completed, the office has turned future work over to the NASA Headquarters Office of Space and Terrestrial Applications in Washington.

In the early 1970's, in response to a growing national concern for protecting the quality of the environment, NASA decided it could help by monitoring and interpreting enviromental data from satellite-borne experiments.

Langley was chosen as the NASA focal center for the work because of its leadership in remote sensing research and in advanced instrumentation developments. At the same time, other NASA centers were given similar responsibilities: Johnson Space Center, earth resources studies; Goddard Space Flight Center, meteorological research; and Ames Research Center, aircraft flight programs.

An environmental office, while physically located at Langley, reported directly to NASA Headquarters, coordinating the research of several NASA centers



Gossamer Albatross on Display—Visitors and employees at the Johnson Space Center get a look at the fragile contraption that flew the English Channel. The pedal-powered Albatross went on exhibit in April in JSC's Building 9A, the Space Shuttle mockup and integration facility laboratory. The opening day crowd was addressed by Bryan Allen, the young man who piloted (pedalled) the craft across the channel in 1979. More than just an exhibit, a Gossamer Albatross sister ship has been carefully tested in a joint NASA Langley-Dryden flight research program to study the future of light-weight, low-speed aircraft.

Senior Senator Visits Goddard—Center Director A. Thomas Young, right, escorts Sen. Charles McC. Mathias, R-Md. on a tour of the Goddard Space Flight Center's Solar Maximum Mission facility and domestic information display system. Maryland's Senior Senator, a member of the Appropriations Committee, also discussed with Young and his staff the impact of recent budget cuts and the present status of space programs.

and making program and budget recommendations to Headquarters.

The Langley share of environmental quality research has grown from a $50,000 program employing about 25 people to a $20 million program that—at its height—had more than 200 people, not counting the Environmental Quality Projects Office itself. The office never numbered more than 17 people at Langley, but they were in the middle of many projects.

John Mugler, last head of the office, is quick to point out that the contribution of his relatively small staff was primarily administrative: to formulate, package and promote the kinds of environmental research projects they thought NASA could do best. The most visible evidence of the NASA work has been the orbiting of environmental experiments aboard a continuing series of satellites.

While public attention was focused on the diplomatic significance of the Apollo-Soyuz mission in 1975, a Langley experiment aboard the Apollo spacecraft was quietly taking environmental measurements in the stratosphere. SAM (stratospheric aerosol measurement) was one of many experiments that flew on the mission, but it marked the beginning of the NASA space flight program for environmental research as formulated by the environmental quality office.

The first mission dedicated to monitoring environmental quality was the Nimbus-G satellite, launched in September 1978. Three Nimbus experiments investigated air pollution: one was contributed by the United Kingdom, and two are products of work sponsored at Langley by the environmental office. One Langley experiment, LIMS (limb infrared monitoring of the stratosphere) is providing infrared measurements of ozone, water vapor, nitrogen dioxide and nitric acid; the second Langley experiment, SAM II, is taking a closer look at aerosols in the atmosphere.

SAGE (stratospheric aerosol and gas experiment) added to the alphabet soup of satellite-launched experiments in eary 1979. Its sole mission is to determine the distribution of stratospheric aerosols and ozone on a global scale.

Satellite measurements of the Earth allow a broad view of pollution and weather systems that transport it. Pollution that begins in one region may often affect either the environmental quality or the weather of another region but, without the long-distance view of an orbiting spacecraft, it may not be obvious.

A favorite example cited by Bob Rinehart, Environmental Quality Projects Office technical assistant for eight years, is a satellite picture of Gary, Ind., and the eastern shore of Lake Michigan, taken one recent winter. Without that picture, it would have been very difficult to convince a steelworker in Gary that pollution from his plant and others contributed to a snowstorm on the shore of Lake Michigan, 75 to 100 miles northeast of Gary.

The photo was as clear as a roadmap. Particulates from the steel mills had combined with water vapor and could be seen as cloud-like plumes extending from Gary straight into a huge cloud over the eastern half of the lake. Exactly parallel to the cloud, for many miles inland, was a white blanket of freshly fallen snow.

In spite of impressive technological achievements by NASA in designing remote environmental sensors and putting them into orbit, Mugler puts those achievements into perspective by explaining that "the satellite flight programs are a means to an end, not the end product itself."

The success of the multi-center research program that has evolved is measured in the vast amount of useful information that NASA experiments have made available to the scientific community and to agencies like the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, the United Nations and others.

The growth of NASA's program has also been good for the agency and for Langley, according to Mugler. "Because of our focal center responsibilities," he says, "Langley has been able to build an aggressive, and still enlarging, atmospheric and water quality program.

Investigations for Atmospheric Studies

The National Aeronautics and Space Administration has selected 26 scientific investigations to be studied for possible inclusion aboard two Upper Atmosphere Research Satellite missions proposed for the late 1980s.

The missions will focus on a comprehensive investigation of the Earth's stratosphere, mesosphere and lower thermosphere to better understand the Earth's upper atmosphere, the response of the ozone layer to changes and the role of the upper atmosphere in climate and climate variability.

NASA officials emphasize that the program has not yet been approved by Congress, but early solicitation of scientific participants and investigations allows for mission definition and a prompt start when approval is received.

The 26 investigations, 23 from the United States, two from the United Kingdom and one from France, include 16 experimental and 10 theoretical investigations. They were selected from 75 proposals received by NASA in response to an announcement in September 1978.

Some 90 other researchers are associated with the selected investigations. The U. S. investigators are from eight universities, six government laboratories and two private organizations.

Each country will be responsible for funding its own investigations and its participation in support of instrument development. The initial study phase cost to the United States, including the selected U.S. investigations, is expected to total about $5 million over two years.

Focusing on the atmosphere between 10 and 20 kilometers altitude, the proposed program will use remote sensors to measure trace gases, temperature, winds, and energy influx and losses. Theoretical studies, including atmospheric simulation modeling, will be closely coupled to the experimental measurements.

The program as presently proposed would involve two satellite missions, each with a nominal lifetime of 18 months. Launched one year apart, the two satellites should provide a total nominal data period of 30 months. The satellites will be carried into orbit by the Space Shuttle.

To allow the first satellite to observe each local area at a variety of different local times, it will be placed into a 56 degree inclination orbit. The second mission is proposed for a 70 degree inclination orbit to provide global coverage and measurement of high latitude energetic processs.

The proposed missions are part of the Environmental Observations program of the NASA Office of Space and Terrestrial Applications. The project management, including the selected investigations, is the responsibility of NASA's Goddard Space Flight Center.

Dryden's Immortal "Gooneybird"—Amid triplesonic YF-12 aircraft and sleek, needle-nosed research jets, a venerable C-47 still serves in the Dryden center's flight operations. The C-47 (civilian DC-3) is probably the world's most honored plane and this one was built at the Douglas plant in Oklahoma City in 1943. Dryden's aircraft flies personnel and material to the various dry lakebeds in support of research projects. Recently, it was used as a test bed, carrying a system that visibly showed the presence of wing tip vortices in flight.

Some Heavy Lifting—Astronauts Bruce McCandless and Joseph Kerwin train for the future and the potential of permanent structures and platforms in space. Using the neutral buoyancy simulator tank at the Marshall center, assisted by swimmers, the astronauts are evaluating methods and equipment that might be employed to service large structural beams in the space environment.

Lewis Awards Fuel Cell Contract

A $4-million contract to United Technologies Corp., Power Systems Div. of South Windsor, Conn., has been awarded to develop further fuel cell technology for electrical utility applications.

The 18-month agreement was made under the Development of Energy's phosphoric-acid fuel cell systems program, managed by NASA's Lewis Research Center, Cleveland, in the continuing effort to develop high-efficiency, fuel-flexible power generation technologies to reduce U.S. dependence on scarce fuel while meeting environmental standards.

The bulk of the phosphoric-acid fuel cell technology development effort to this point has been directed to demonstrating the operational feasibility of a precommercial 4.8-megawatt power plant. It is recognized, however, that the key to developing commercially viable power plants hinges on advancing the basic fuel cell and stack technology to a level which offers improved cost, performance and operating life.

Work to be performed under this contract will involve further identification and evaluation of low cost cell materials with greater corrosion resistance, catalysts with improved activity and stability, and electrode structures with greater tolerance to higher temperature and pressure operating conditions.

The materials, catalysts and structures are to be evaluated in both subscale single cell and full scale stack endurance and performance tests. Also, technology development work will be done on processing the cell structural elements in the large size anticipated for commercial scale systems.

Heat Treatment Detection of Cancer

A team of engineers from NASA's Johnson Space Center, Houston, working with local cancer researchers has developed an advanced heat treatment system for use on certain types of human cancers.

The development was independent of other recently announced NASA work evaluating the use of a microwave technique to detect cancer. The Houston heat treatment method also employs microwave technology.

Research has shown that heat can destroy cancer cells without harming adjacent healthy tissue. Methods for producing the heat have become more sophisticated but until recently were plagued with problems including burns to the patient receiving the treatment.

The Johnson center had agreed in 1978 to assist bio-medical scientists of the Stehlin Foundation for Cancer Research at St. Joseph's Hospital in

Study in Contrast—The first weather picture ever returned from space, on the left, was from the TIROS-1 satellite in April 1960. The recent view of the Continental U.S. on the right was transmitted by the TIROS-N series spacecraft, the newest and most advanced in the family of meteorological satellites. In 20 years, the RCA-built trackers have returned more than 3.5 million views of the world's weather.

Houston with technical aspects of a radio frequency heat treatment system.

The engineering challenge which the St. Joseph's researchers posed to the space center technicians was to improve both the equipment and the technique. The first step was to develop a machine for testing on small animals.

The NASA center's experiment systems division has been developing the equipment with its safety and reliability division reviewing each advance in equipment or technique. Kumar Krishen, technical coordinator for the project, said "developing the advanced human system involved acute concerns about the safety and reliability of the equipment and the instrumentation used to monitor experiments."

The Johnson team delivered an experimental human treatment system to St. Joseph's Hospital in January. "The system uses a gradual buildup of power to a preselected level," Krishen said, "two pairs of electrodes concentrate the power at the tumor. Heating of the skin and surrounding healthy cells is dispersed much better with the new design."

The small animal system is being used to help establish human levels and to study the effects of heat treatment at the cell level. "The challenge we now face," Krishen said, "is to deliver the heat with minimal side effects. We are investigating the possibility of transmitting the radio waves through the patient with electrodes which do not touch the skin. They would act like antennas. Right now the electrodes must touch the patient's skin."

The experiment systems division group at Johnson normally is involved in the development of microwave devices for the study of Earth's weather, soil conditions and agricultural crops.

Researchers at NASA's Langley Research Center in Hampton, Va., confirmed last November that they are evaluating an instrument which makes use of microwave technology as a detector of cancerous tumors in the human body.

The device, called a microwave applicator, is being tested at the Eastern Virginia Medical School at Norfolk General Hospital. The project began when a Langley researcher suggested that Langley's microwave experts, who normally work on satellite communications and other related space projects, should get involved in some way with using microwave techniques to detect and treat cancer.

The device demonstrated it could locate tumors in 14 known cancer patients and also found a cancerous site in one patient which had been undiscovered by conventional techniques.

The microwave instrument contains a sensitive radiometer that can measure temperature variations of less than 0.1 degree C. Because cancerous tissues are hotter than surrounding normal tissues, they are thus detectable by the applicator.

The microwave applicator has the advantage of being used outside the body and could become relatively inexpensive if mass-produced. If it proves itself after an extensive series of hospital and laboratory tests, it could become standard equipment in doctor's offices.

Contractor News

Boeing Company, Lockheed California Company, and McDonnell Douglas Corporation have been awarded NASA contracts for continued technology studies on an advanced supersonic transport plane. Each of the major aircraft manufacturers received an approximate $1.15 million contract and each will work in the same discipline technology areas, but within their individual basic design concepts. NASA has asked the three contractors to draw on past studies and to update them, looking especially for economic considerations, reduced fuel consumption and reduced noise in supersonic cruise flight. The contracts each cover a period of about 14½ months and they will be managed by Langley Research Center.

Bionetics Corporation, of Hampton, Va., has won a contract extension of almost two million dollars for reference standards services and the calibration of instruments at Kennedy Space Center. A small business firm, Bionetics has the job of maintaining KSC measurement standards and calibrating all center test equipment, assuring accuracy in operations. The cost-plus-fixed-fee contract extension covers the period May 1, 1980, through April 30, 1981, and brings the total value of the 1976 agreement to almost $6.5 million.,

Automation Industries, Inc., Vitro Services Division, of Industrial Park, Fort Walton Beach, Fla., has been awarded a contract by the Wallops Flight Center for purchase of a Mobile C-Band Instrumentation Radar System. The million dollar, fixed price contract calls for delivery within 20 months. The new mobile radar system will replace an existing acquisition radar to update the center's tracking capabilities.

Holloway Corporation, of Titusville, Fla., has received a million dollar contract award from the Kennedy Space Center for the fabrication of power system equipment. Delivery of equipment should begin in late November 1980 and be completed by August 28, 1981. Holloway will provide direct current power systems and high frequency power systems to supply supplementary electrical power for the Orbiter processing facility and mobile launch platform facilities both at KSC and Vandenberg Air Force Base, Lompoc, Calif. Kennedy and Vandenberg are the East and West Coast launch sites for the Space Shuttle.

W. B. Venables & Son, Inc., of Mechanic Street, Laurel, Del., has been awarded a one million dollar fixed price contract by the Wallops center for construction of a new facilities operation building on the WFC main base. Completion of the building, set for March 30, 1981, will allow for most of the technical support shops (carpenter, electric welding, garage, etc.) to be centrally located. The shops are presently widely dispersed in obsolete World War II buildings.

Pan American World Airways, Inc., Aerospace Service Division, of Houston, has signed an extension to its contract with the Johnson Space Center covering plant maintenance and operations at JSC. The cost-plus-award-fee contract is for operation of all center utilities and maintenance of buildings, roads, ditches and special equipment. The contract value is set at over $9 million.

Rand Sperry Corp., Sperry Univac Division, of Blue Bell, Pa., has reached agreement with the Johnson Space Center on a $6.15 million contract covering lease and maintenance of automatic data processing equipment at JSC. The contract covers people, equipment, materials, facilities, services and management of all Univac activity at Houston.

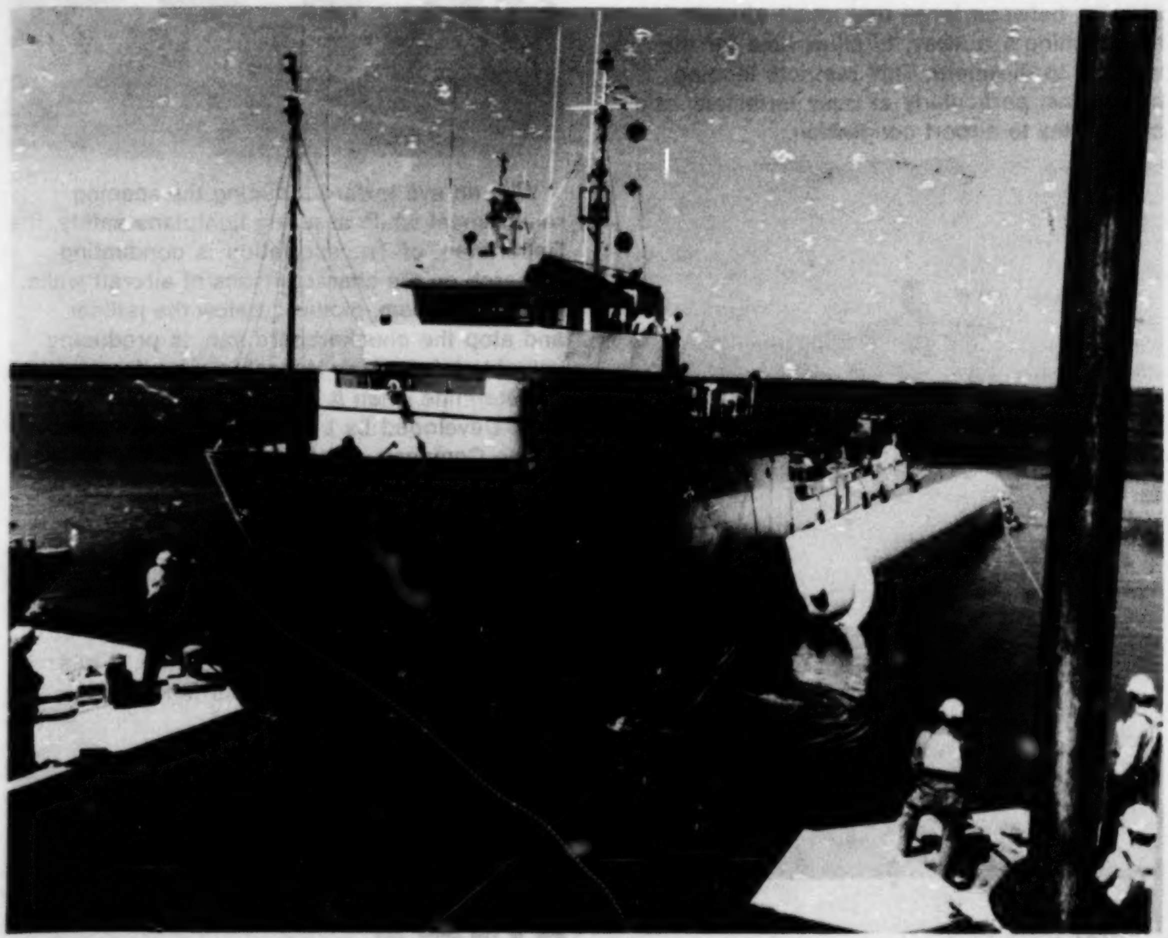
Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Harry Reid, Jr., NASA/Marshall	Coal-shale interface detector	4,195,512	MSFC
William M. Ingle, Carl Goetz, Motorola, Inc., Phoenix, Ariz.	Quartz ball valve	4,195,666	NRO/JPL
Sidney R. McClure, NASA/Goddard	Method and apparatus for holding two separate metal pieces together for welding	4,196,840	GSFC
Eric G. Laue, Caltech/JPL	Passive intrusion detection system	4,197,530	NRO/JPL
Richard A. Parr, Mary H. Johnston, John C. McClure, NASA/Marshall	Preparation of monotectic alloys having a controlled microstructure by directional solidification under dopant-induced interface breakdown	4,198,232	MSFC
Warren W. Christensen, Ludwig A. Mayer, Fritz H. Woeller, San Jose University, San Jose, Calif.	Chelate-modified polymers for atmospheric gas chromatography	4,198,792	ARC
Charles M. Fleetwood, Jr. Stephen H. Rice, NASA/Goddard	Method of forming a sharp edge on optical device	4,198,788	GSFC
Michael J. Mirtich, James S. Sovey, NASA/Lewis	Modification of electrical and optical properties of polymers	4,199,650	LeRC
John T. Polhemus, Wilbur H. Cash, Martin Marietta, Denver	Pulse transducer with artifact signal attenuator	4,198,988	DFRC
Catherine C. Johnson, Theodore J. Wydeven, NASA/Ames	Reverse osmosis membrane of high urea rejection	4,199,448	ARC
Israel Paz, NASA/Johnson	Tri-State delta modulator	4,199,722	JSC
William F. Williams, Seymour B. Cohn, Caltech/JPL	Dual band combiner for horn antenna	4,199,764	NRO/JPL
Anthony Fortini, John M. Kazaroff, NASA/Lewis	Heat exchanger and method of making	4,199,937	LeRC
Earl R. Collins, Jr. Caltech/JPL	Geological assessment probe	4,196,619	NRO/JPL
Kazimiera Paciorek, Ultrasystems, Inc., Irvine, Calif.	Heat resistant polymers of oxidized styrylphosphine	4,200,721	JSC

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January 17	Atlas Centaur	ETR	DOD Navy. Reimbursable
SMM-A	February 14	Delta	ETR	NASA. Scientific Solar Maximum Mission.
NOAA-B	May	Atlas-F	WTR	NOAA Weather. Reimbursable.
GOES-D	August	Delta	ETR	NOAA Weather. Reimbursable.
Intelsat V-A	September	Atlas Centaur	ETR	Intelsat communications. Reimbursable.
Navy-20	October	Scout	ETR	DOD Transit. Reimbursable.
SBS-A	October	Delta	ETR	Satellite business systems. Reimbursable.
FLTSATCOM-D	November	Atlas Centaur	ETR	DOD Navy. Reimbursable.
Intelsat V-B	December	Atlas Centaur	ETR	Intelsat communications. Reimbursable.



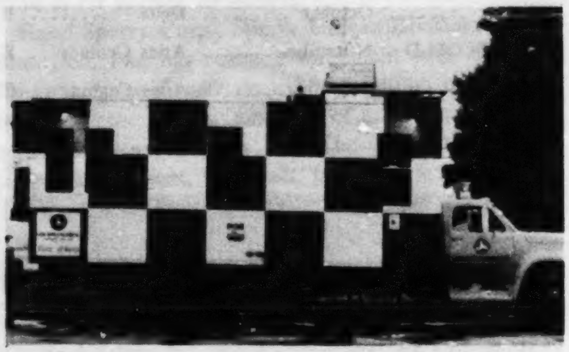
Docking the Booster—At the Kennedy center's Hanger AF slip, a leased recovery ship delivers a Space Shuttle solid rocket booster simulator now being tested in Port Canaveral waters. During sea exercises, ships will pick up the booster frustums and parachutes, then steer a nozzle plug remotely into the aft end of the simulator and take it into tow.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Airport Safety Aid

Large aircraft such as commercial jetliners produce powerful wakes, or vortices, which can be hazardous to small planes following closely behind. For that reason, the Federal Aviation Administration requires a five-mile spacing between large and small aircraft approaching a runway, to allow time for the vortices to dissipate. This restricts landing operations, particularly at busy terminals, and contributes to airport congestion.



With an eye toward reducing the spacing requirement while assuring lightplane safety, the Department of Transportation is conducting research on the characteristics of aircraft wake. A spinoff system, pictured below the jetliner and atop the checkerboard van, is producing valuable information to enable airport controllers to determine when it is safe for a lightplane to land. Developed by Lockheed Missiles and Space Company, Sunnyvale, Calif., it is called a Laser Doppler Velocimeter.

The device was originally developed by NASA's Marshall Space Center for use in measuring airflow disturbances in wind tunnels and in flight. Lockheed, which worked on the project, applied the experience to its new remote wind sensing device. To date, it has monitored thousands of airliner landings to better the airport traffic system.

For the benefit of all . . .

NASA
National Aeronautics and Space Administration

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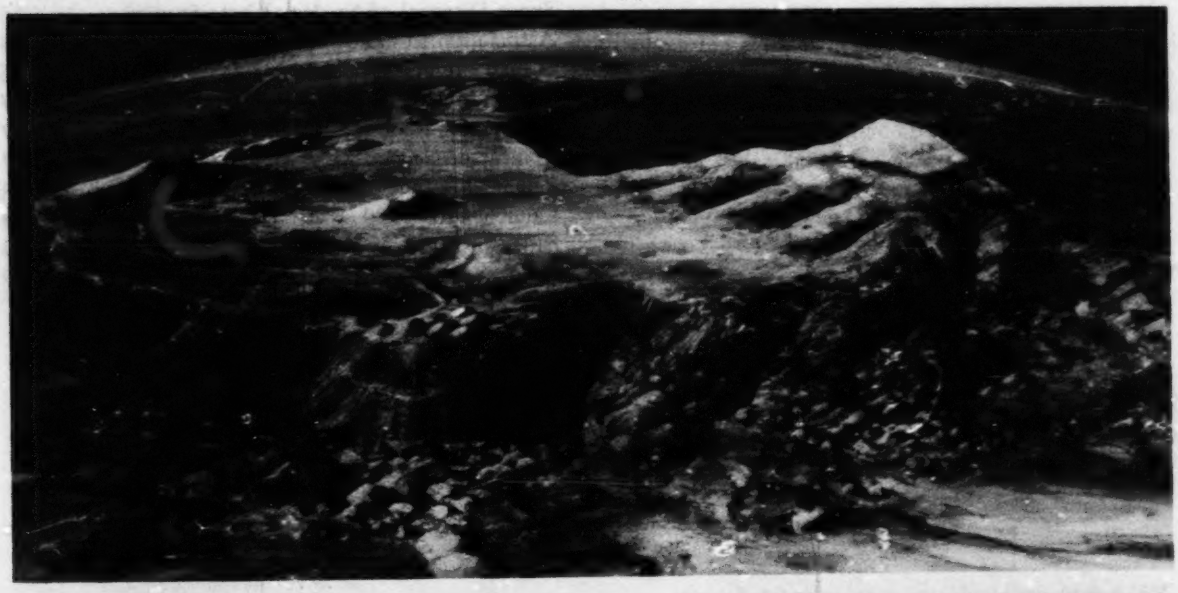

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Cover

Venus Highland—Artist's concept of Ishtar Terra, loftiest and most dramatic continent-sized highland region on Venus, is based on radar mapping accomplished by the Pioneer Venus orbiter. Western part of Ishtar is mostly a smooth plateau, but the eastern portion, at right, changes to a huge uplifted, broken region topped by the highest point yet found on Venus, a mountain massif called Maxwell Montes. Version below has the outline of the continental United States superimposed to illustrate the relative size of Ishtar.

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Major Venus Features Identified

Based on radar data returned by Pioneer Venus, scientists are beginning to identify major surface features on the cloud-shrouded planet, and are working with an international nomenclature group to name them after mythical goddesses.

The operating spacecraft, which has been in orbit around Venus since December 1978, has mapped a belt extending completely around the planet, except for a narrow strip which is currently being filled. The spacecraft's radar mapper instrument measures the Venutian surface from 75 degrees north latitude to 63 degrees south latitude, or 83 percent of the planet's total surface.

The Venus surface has never been visible because of the clouds which permanently cover the planet.

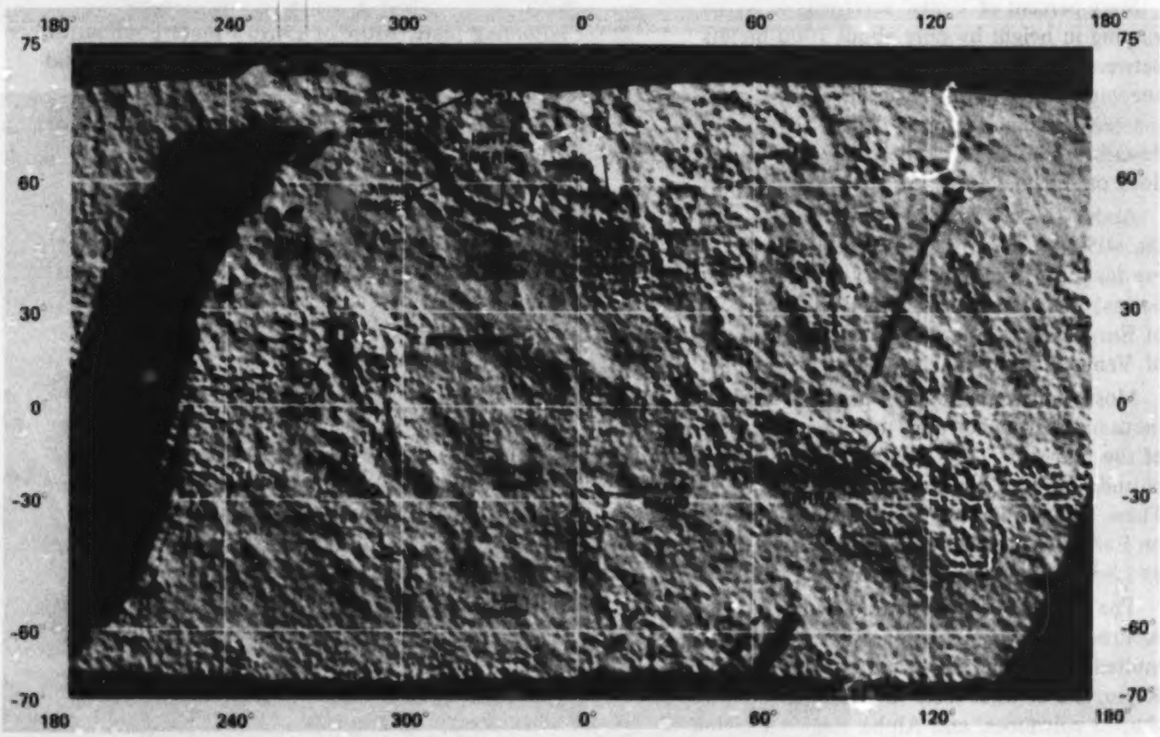
Investigators have identified by radar two huge continent-like features on Venus. One centered at 65 degrees North, is the size of the continental United States and contains mountains as high as Everest, the loftiest peak on Earth. The other region, centered about 5 degrees south of the equator, is half as large as Africa.

Other features on Venus include deep rift valleys, rolling plains and high plateaus.

Scientists have proposed that the northern highland mass be named Ishtar Terra, for Ishtar, the Babylonian goddess of love and war. Aphrodite Terra has been proposed as a name for the equatorial upland mass, after the Greek goddess of love—known to the Romans as Venus.

Ishtar was one of the Babylonian (Assyrian) trinity of major gods. Known as "the lady of battles," she often was depicted riding on a lion, weapon in hand. She was daughter of the Moon and sister of the Sun. Aphrodite (Venus), for whom the planet is named, is a major figure in the Greek pantheon.

Names for the two major features were proposed by the principal scientific investigators of the Pioneer radar mapping team: Dr. Gordon H. Pettengill of the Massachusetts Institute of Technology and Dr. Harold Masursky of the U.S.



Preliminary topographic map of Venus produced by the U.S. Geological Survey is based on radar data from the Pioneer Venus orbiter which continues to operate as planned. Black curved gap at left is still to be filled by the orbiter's radar-mapping instrument. Before Pioneer, Earth-based radar was able to measure less than one percent of Venus' topography. This map covers about 80 percent of the planet.

Geological Survey. They met with the Working Group on Planetary Nomenclature of the International Astronomical Union. The group has decided that nomenclature policy for major features on Venus should reflect mythical goddesses from various cultures. Minor features will be named for other mythical female figures, and still smaller circular features will be named for famous women who are no longer living. The group has members from the United States, the Soviet Union and Canada.

The Pioneer project is managed by the Ames Research Center. The orbiting spacecraft and four probes that penetrated the planet's clouds were built by Hughes Aircraft Co., El Segundo, Calif.

Pioneer findings suggest that Venus' terrain and geology have both strong similarities to and major differences from those of any known planet. The surface is gently rolling, with marked local highs like the North American continent. However, not counting Earth's oceans, Venus' range of elevations is somewhat greater than Earth's, going from 2.9 kilometers below the average spherical surface to 10.8 km above that level.

Sixty percent of Venus' surface is relatively flat, varying in height by only about 1000 meters between high and low points. This huge, planet-encompassing plain lies at a 6050-km radius from the center of the planet. (This 6050-km radius describes a reference sphere, much as sea level does on Earth.)

About 16 percent of Venus' surface lies below the 6050-km mean radius. Such low-lying regions are far more common on Earth (they are the ocean basins) than on Venus, occupying nearly two-thirds of Earth's surface compared to the one-sixth of Venus.

Most of the remaining 24 percent ranges a few thousand feet higher than the plain. Only 8 percent of the planet is "true highlands," reaching maximum altitudes of 10.8 km above Venus' rolling plains. These true highlands may resemble similar areas on Earth. They may be made of very light rock, and hence "float" much higher than other features.

The largest of the highland regions, Ishtar and Aphrodite, are rough, apparently fractured and faulted. Two other notable highland areas are Beta Regio, site of what seem to be two giant shield-shaped volcanoes, and Alpha Regio, a region of rough, probably geologically old terrain.

The Venus crust, although not as thick as those of Mars and the Moon, appears thicker than Earth's—so thick that it has choked off most crustal movement or plate tectonics.

The lower layer of the Venus crust apparently consists of heavier basalt-type rocks and wraps the entire planet. On top of this is a layer of light, granitic-type continental rock. (Russia's Venera 8 found the radioactivity of rocks in one area of Venus' plains to be like that of granite.) This ancient layer of lighter rocks may form a single huge planet-girdling continent, covering about 84 percent of Venus' total surface. Perched on top of this giant Venusian continent are the smaller but still continent-sized highland regions.

Venus' crust appears to be one huge tectonic plate, compared with Earth's six major plates and several minor ones. Due to continuous formation of new plate material, Earth's plates constantly expand and grind together. Plates which adjoin are forced over and under each other.

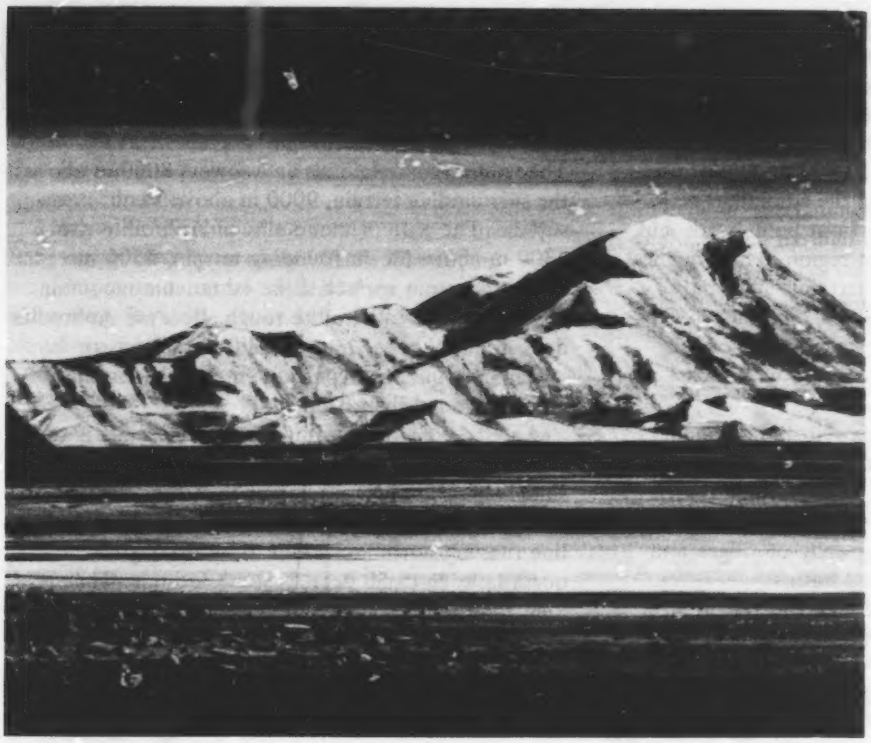
There is no evidence of any Venus features similar to Earth's mid-ocean ridges, where molten basalt wells up to form new crust. On Earth, old crust is carried back into the hot interior by the submergence of one tectonic plate beneath its adjoining plate. Most of Earth's plate boundaries are at the edges of continents, but some are in mid-ocean.

There appear to be abundant primordial impact craters like those on Mars and the Moon scattered over the surface of Venus. These craters have diameters above 75 km, large enough for Pioneer to observe. Most of Venus' surface (and hence crust) appears to be ancient terrain. Atmospheric heating, water loss and crust formation apparently took place in the first 1-2 billion years of the planet's history.

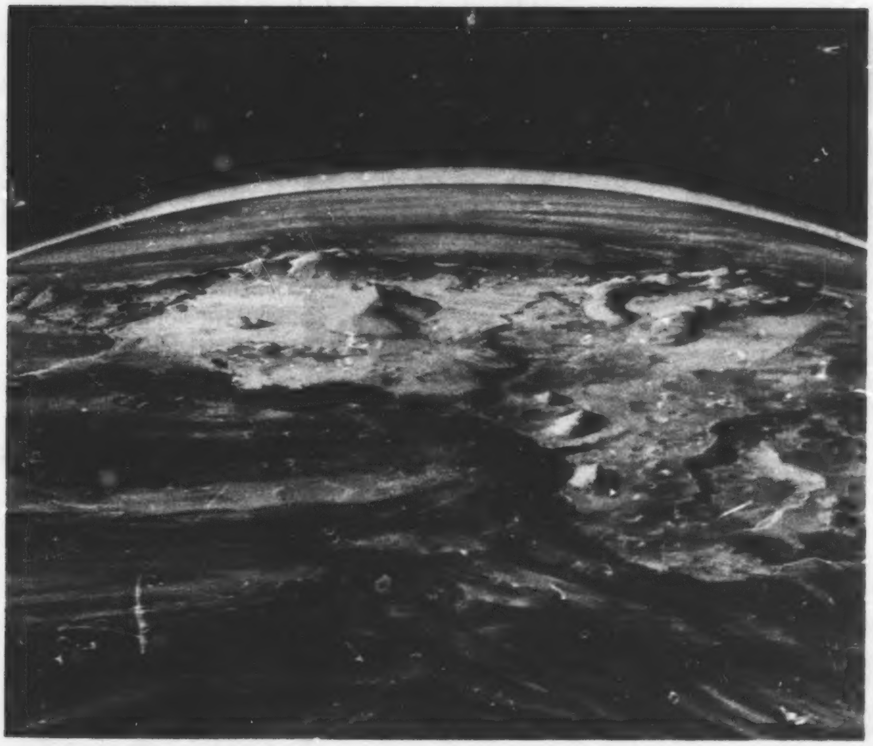
The highest and most dramatic continent-sized highland region on Venus is Ishtar Terra, a high plateau, carrying several mountain ranges.

The western part of Ishtar appears to be a smooth plateau, called Lakshmi Planum, about 3300 m above the Venus "sea level," the 6050-km radius from the planet's center. Lakshmi is bounded on the west and north by mountains ranging 2300 to 3300 m above the plateau, or 5700 to 7000 m above "sea level". The western mountains have been tentatively named Akna Montes and the northern range, Freyja Montes.

The Ishtar plateau is about as high as the Tibetan plateau, but twice as large. The central area of the plateau is smooth in the radar images and may be



Artist's concept of highest Venus peak, Maxwell Montes, as seen from smooth plateau to its west.



Artist's concept of Aphrodite Terra, largest highland region on Venus.

covered with relatively young lavas. The huge escarpments around the plateau's edge are quite steep.

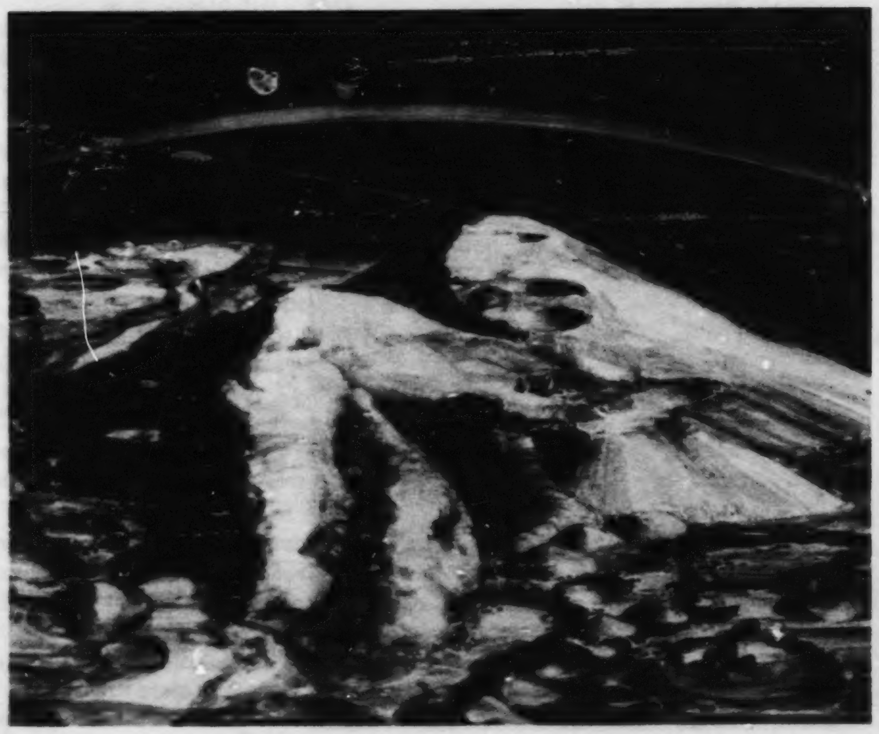
The highest point found on Venus has been named Maxwell Montes. This huge area of uplifted terrain occupies the entire east end of the Ishtar Terra highlands. Its peak is 10,800 m above "sea level" and 9000 m above the adjoining Lakshmi plain. Observations from both Earth and Pioneer suggest this mountain region is the roughest part of the planet—jumbled terrain, changing abruptly from the smooth plateau. The radar brightness indicates that the steep slopes of this Mount Everest of Venus are covered with rocks larger than 10 cm.

On the eastern flank of Maxwell, Pioneer data show a circular 100-km-diameter dark feature more than 1000 m deep. This may be a volcanic crater. East of Maxwell, extending for 100 degrees of longitude, is a complex topography of ridges and troughs, including many closed basins.

The largest continent-sized highland region on Venus is Aphrodite. It is comparable in size to the northern half of Africa, and consists of two mountainous areas separated by a somewhat lower region. Situated almost on Venus's equator, Aphrodite Terra runs almost directly east and west for 9600 km.

Unlike Ishtar, a relatively level plateau carrying high mountains, the Aphrodite highland rises to various heights above the mean planet surface. The western mountainous area towers 8000 m above the surrounding terrain, 9000 m above Venus mean surface. The eastern mountains of Aphrodite rise 3300 m above the surrounding terrain, 4300 m above the mean surface. Like Ishtar, the mountain terrain appears to be quite rough. Because Aphrodite does not appear to contain uplifted plateaus or volcanic mountains, Aphrodite may be older and more degraded than Ishtar.

About 30 degrees north latitude on Venus is Beta Regio, apparently consisting of two huge shield-shaped volcanoes, larger than the Hawaii-Midway chain. Beta Regio appears to be on a fault line running north and south, from 40 degrees north latitude to 50 degrees south latitude. This long fault zone connects several other highland features, which may be volcanic, south of Beta Regio. The two huge, adjoining mountains (smooth on the surface and shaped like the very wide-based Hawaiian volcanoes) cover a north-south distance



Artist's concept of Beta Regio, twin mountains rising 4 kilometers above Venus' great plains.

of about 2100 km. Aside from their appearance, rocks making up the twin Beta mountains appear to be basaltic and hence very likely of volcanic origin. (The Soviet spacecraft Veneras 9 and 10 landed just east of Beta, and found the rocks there to have radioactive element concentrations similar to basalts.

The two shield-shaped mountains making up the Beta region have been named Theia Mons (the northerly mountain) and Rhea Mons (the southerly mountain). Both rise about 400 m above the planet-spanning plain; i.e., above Venus' mean surface.

The fourth notable highland feature on Venus, Alpha Regio, is a rough region about 1800 m above the Venusian great plain. Alpha Regio is about 25 degrees south of the equator and 6400 km west of Aphrodite. Radar imaging shows that it has extremely rough terrain with parallel fractures through the whole feature. It may combine old and new geologic forms and resembles the basin and range structure of the western United States.

As noted, a relatively flat, rolling plain covers 60 percent of Venus' surface. Radar imaging shows many circular, dark features with bright central spots on this rolling plain. These apparent craters with diameters of 400 to 600 km characteristically have depths of only 200 to 700 m. The bright, central areas could be the central peaks, typical of impact craters.

The very small depths and the very large diameters of these apparent craters, compared with the Moon and Mars, can be explained by "surface rebound" like that found on Jupiter's planet-sized moons. (The apparent wide-spread cratering suggests that Venus' heavily-cratered ancient crust is preserved over much of the planet.)

The largest low area so far found on Venus is centered west of Ishtar at 70 degrees north. At its deepest point, this great basin is about 3000 m below Venus' great plain region. This low area, like others on the planet, is smooth, and lacks large crater forms. Like Earth's ocean basins it may be relatively young geologically and filled in by basaltic lava flows. It is about the same size as the North Atlantic ocean basin.

The lowest point on Venus appears to be in the rift valley just east of Aphrodite, at about 2.9 km below Venus' mean surface. This trench is deeper than the Dead Sea rift, but only one-fifth the depth of the Marianas trench in the western Pacific. It is roughly the same depth as Valles Marineris, the great canyon on Mars. While Venus apparently has no plate tectonics, this rift valley and another parallel to it, both in the region east of Aphrodite, seem comparable to tectonic rifts on Earth. Here, new rock material wells up out of the molten interior.

In general, the jumbled region east of Aphrodite is characterized by high ridges and deep valleys. There is a similar region east of Ishtar.

The foregoing Venus information was based on a paper prepared by Drs. Masursky, Pettengill and others, for a Fall issue of the Journal of Geophysical Research.

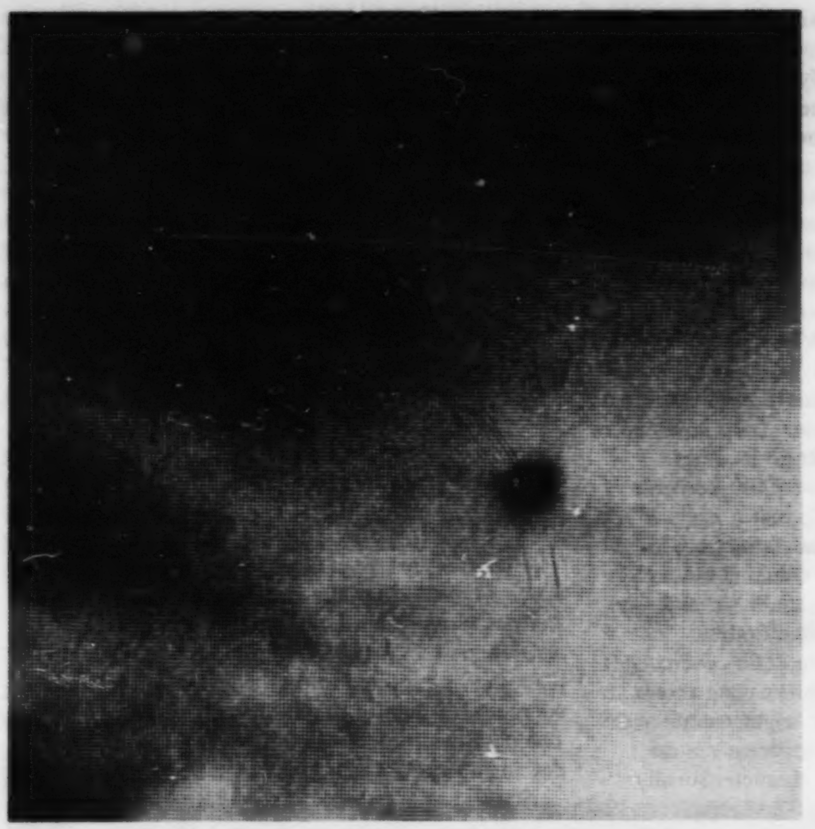
Coal Gasification Project Advances

A contract has been awarded by the Marshall Space Flight Center for systems engineering and analysis support during the first phase of development of a Tennessee Valley Authority coal gasification plant that is expected to produce a gas with the energy equivalent of 50,000 barrels of oil per day. The plant will process 20,000 tons of coal each day in full production.

BDM Corp. of McLean, Va., a systems engineering company, was awarded the $699,864 contract by Marshall. BDM will perform systems analyses and trade studies for plant systems and assist in the comparative evaluation of conceptual designs. Mittelhauser Corp., a Downers Grove, Ill., architectural and engineering design organization, will assist BDM.

Talks between TVA and Marshall Center officials last summer led to a formal agreement in January that Marshall would provide technical support to the project and TVA would supply the funds for contracted effort. TVA officials said the cooperative effort was entered into with Marshall because "the Center possesses extensive experience in conceptualizing, designing and developing complex space systems and this experience can be applied to the coal gasification project."

Marshall's role includes providing technical support to TVA, integration of the work accomplished by selected contractors, and evaluation of the different conceptual designs resulting from contracts. Marshall also will develop a plan for supporting technology development work to be conducted during subsequent phases of the project.



Newly discovered 15th moon of Jupiter, at bottom, and its shadow, at end of streak in Jupiter Cloud, were photographed March 4, 1979 by Voyager 1 from a distance of about 1.4 million kilometers.

15th Jupiter Moon Discovered

A scientist at the Jet Propulsion Laboratory discovered another moon of Jupiter—its 15th—while he was searching through pictures taken by the Voyager 1 spacecraft.

The satellite, tentatively called 1979 J2, was found by Dr. Stephen P. Synnott of the Voyager Optical Navigation Team. The pictures he was examining were taken by Voyager 1 about 4½ hours before the spacecraft made its closest approach to Jupiter, March 5, 1979.

The moon, the second discovered from Voyager photographs, is estimated to be 70 to 80 kilometers in diameter. It orbits the planet every 16 hours, 16 minutes, at a distance of 151,100 km above Jupiter's cloud tops—between the orbits of the satellites Amalthea and Io.

Synnott was searching Voyager 1 images to confirm the existence and orbit of the other newly-found satellite, 1979 J1, when he noticed a shadow stepping across the face of Jupiter where no shadow should have been.

Synott was able, from two shadow observations, to predict the orbit of the satellite. This allowed him to find evidence of the satellite in seven earlier images.

Synnott also has confirmed the discovery of 1979 J1 in October 1979 from photographs taken July 8, 1979, by Voyager 2. That moon orbits Jupiter at a distance of 57,000 km above the clouds.

Satellite 1979 J1 was estimated to be 30 to 40 km in diameter. It makes one orbit of Jupiter every 7 hours, 8 minutes. Some scientists believe 1979 J1 could be a source for much of the fine dust that makes up the Jupiter ring discovered by Voyager.

The two Voyager spacecraft are enroute to Saturn after their successful 1979 encounters with Jupiter. Voyager 1 will make its closest approach to Saturn on Nov. 12, 1980. Voyager 2 will fly past Saturn on Aug. 26, 1981. The latter spacecraft will then continue on to an encounter with Uranus—about a billion miles farther away—in January 1986.

The Voyager project is managed by the Jet Propulsion Laboratory.

Saturn's Day Longer Than Estimated

A team of scientists working for NASA has determined that the rotation period of Saturn—the length of a day on the planet—is almost 25 minutes longer than previously estimated.

Using bursts of radio noise from Saturn, recorded by the two Voyager spacecraft now enroute to the planet, the length of one day was determined to be 10 hours, 39.9 minutes.

Astronomers using Earth-based observations of the ringed planet, had calculated the length of a day at about 10 hours, 15 minutes, but admitted their measurements lacked accuracy.

Determination of the longer length of a Saturn day was made by Michael Kaiser and Michael Desch of NASA's Goddard Space Flight Center and James Warwick and Jeffrey Pearce of Radiophysics, Inc., Boulder, Colo. All are members of the Voyagers Planetary Radio Astronomy team headed by Warwick.

The lack of accuracy of earlier measurements was due in part to the fact that Saturn does not have a solid surface. Observers can see only the tops of the planet's clouds, which have no sharply defined features to allow accurate determination of rotation.

Warwick's team recorded radio signals from a variety of sources in the sky during January 1980, when Voyager 1 was more than 380 million kilometers from Saturn, and Voyager 2 was more than 554 million km from the planet.

By gradually eliminating signals coming from the Sun, Jupiter and other sources, the investigators determined that the signals they were receiving every 10 hours, 39.9 minutes originated at the north pole of Saturn, and were precisely controlled by the planet's rotating magnetic field.

Several years ago radio astronomers were able to pin down the rotation rate of Jupiter using this same method. Scientists feel it is the most accurate method of determining rotation. Although Earth, Jupiter and Saturn are all emitters of radio signals, scientists do not as yet understand how these signals are generated.

Voyager 1 will make its closest approach to Saturn Nov. 12, 1980. Voyager 2 will pass the planet Aug. 25, 1981. The Voyager Project is managed for NASA's Office of Space Science by the Jet Propulsion Laboratory.

Intelsat First of Many—NASA and Intelsat officials sign the first Space Transportation System launch services agreement at a ceremony in Washington, May 16, 1980. Signatories, left to right, are Dr. Robert A. Frosch, NASA Administrator; Robert F. Allnutt, NASA Associate Deputy Administrator; Francis Latapie, Acting Deputy Director General for Intelsat Administration; and Santiago Astrain, Intelsat Director General. The agreement sets the terms of services and payments for launch of Intelsat communications satellites by the Space Shuttle and, during the transition phase to full Space Shuttle operations, by the Atlas-Centaur expendable launch vehicle. Launch services agreements with other early Space Shuttle users are being negotiated.

NASA Radar Discovers Mayan Canals

Extensive Mayan-built canals hidden for more than 1,000 years beneath a dense rain forest in Guatemala have been revealed by a radar system developed for NASA by the Jet Propulsion Laboratory.

The radar's unveiling of the ancient canal systems, dug by the Maya between 250 B.C. and 900 A.D. in Guatemala and the neighboring country of Belize, may help to answer a question that has long puzzled archeologists: How did the Maya, whose population numbered between 2 to 3 million citizens, feed their people?

The canals were found recently in images taken during an early test (1977-78) of the radar from an aircraft over the cloud-covered jungles of Guatemala and Belize—once the center of the Mayan empire.

The radar (called SAR for Synthetic Aperture Radar) can penetrate clouds and provides higher resolution for comparable antenna size than other radars. It has been developed by NASA and the military. JPL's version was designed to penetrate the dense cloud cover of Venus and provide map-like images of the planet's hidden surface.

Because the tropical region is cloud-covered most of the time, sharp aerial photographs of the jungle area are virtually impossible to obtain. The ability of the radar to penetrate cloud cover, however, enabled researchers to produce clear pictures of the varying layers of foliage. Measurement variations of the height of the layers, called canopy, were detected by the radar and allowed scientists to determine land formations beneath the foliage.

Recently, Richard E. W. Adams, professor of archeology at the University of Cambridge, England, was provided radar images which mapped a stretch of Guatemalan and Belize tropical jungle. The mapping of the area was directed by JPL senior radar scientist Walter E. Brown.

While checking the radar data for evidence of ancient settlements or roadways, Adams was surprised to find unnaturally uniform grid patterns—which looked to be canal systems—in the swampy rain forest surface.

The lattice-like grid unveiled by the radar, if found to be as extensive as indicated on the radar imagery, would prove to Adams that the Maya had used nearly all of the flooded and swampy zones in the Guatemalan and Belize lowlands for raised field cultivation. The canals were made to carry away excess water and free submerged or soggy plots for farming.

Evidence of raised field cultivation would show for the first time that the Maya were forced by population pressure to use a sophisticated intensive agriculture system to support the millions living in and around their cities.

Such canal systems were known to have been used on a small scale by the Aztecs in Mexico and by the Maya in Belize, but archeologists never suspected that this kind of intensive agriculture was used as widely as suggested by the radar.

The canals, measuring about one-half meter deep and one to three meters wide, were dug with handcrafted stone blades, mattocks and hoes to drain water away from the swampy rain forests to make small square plots of dry land where crops could be grown.

Archeologists believe the Maya used such farming techniques to grow maize, their principal food, and cacao, from which modern chocolate is made. Cacao was cultivated by the Maya for food and for money, since ancient Mesoamerican civilizations used cacao beans for currency.

Adams, with fellow archeologist Dr. T. Patrick Culbert of the University of Arizona, set out for the Guatemalan and Belize rain forests on Feb. 14, 1980, to see if they could find on the ground what the radar had seen from an altitude of 28,000 feet.

Working with other archeologists in the area, the two scientists compared grid patterns found in the radar data with local topographical maps and aerial photos, and first confirmed that the lattice patterns recorded by the radar appeared where known canals existed.

Then, traveling by car and dugout canoes, Adams and Culbert pushed through the rain forest, navigating in and out of alligator-infested waterways, searching for and finding the narrow ditches outlining the plots of land where the Maya grew their crops—proving that the radar had detected unknown canal systems.

What they found near the Pasion River, for example, were small streams flowing into the river at regular intervals, along with the remnants of small canals frequently leading from lagoons at right angles into the river.

Adjacent to the canals they found the plots of land, (sometimes submerged) now covered with reeds and thick foliage, that had been used as cultivation sites by the Maya. According to Adams,

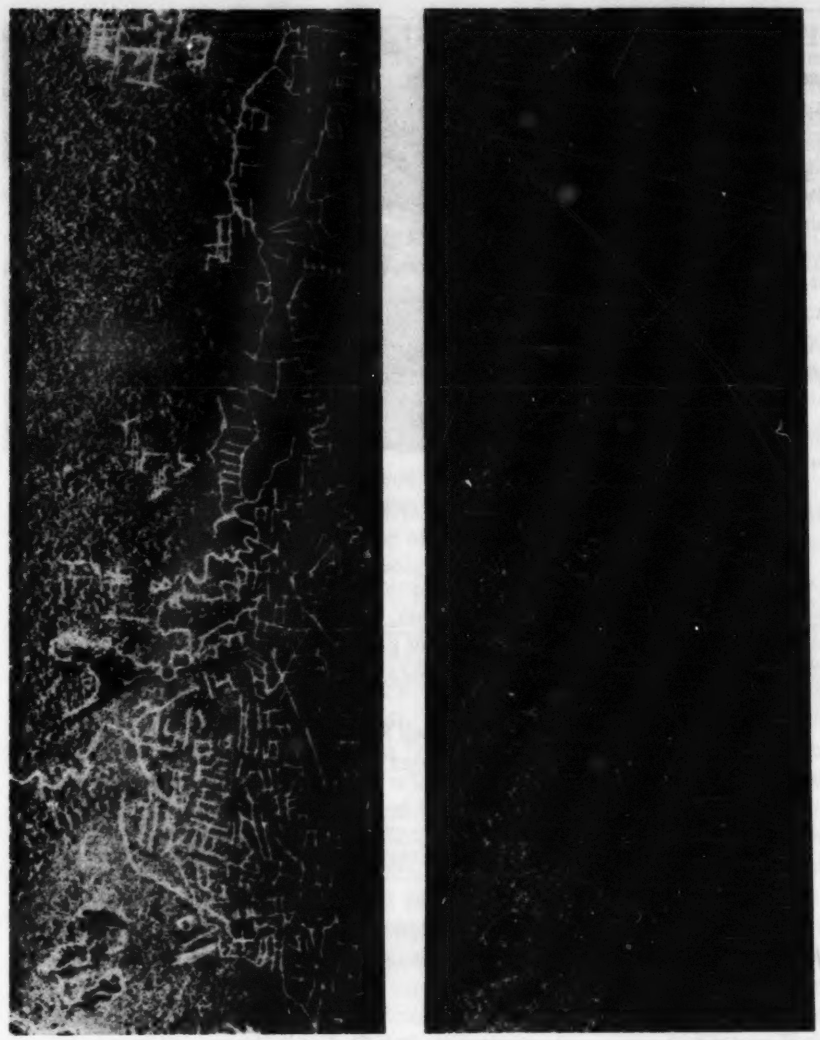


Photo at right is raw radar image of foliage in Guatemalan rain forest. Photo at left shows rectangular patterns and latticing found when the radar imagery was adjusted to penetrate the layers of foliage. Ground searches confirmed the remnants of drainage canals dug by the ancient Maya.

the archeologists found enough evidence to believe that "as much as a third of those particular grid patterns (as seen by the radar) are ancient canals." He estimated that 14,000 square km of canal systems may lay beneath the rain forests of Guatemala alone.

Adams said the next step in determining how extensive the canals are, is to use the radar to produce imagery with even higher resolution in future flights over the area. The previous resolution was set at 1:250,000 to distinguish objects and patterns as small as 15 meters square. A higher resolution of 1:50,000 would show patterns as small as 3 meters square in more detail.

Then, following radar mapping surveys, sites will be selected for archeological excavations, which will determine whether Mayan artifacts like stone tools or structural remains still exist after centuries of flooding. Digging in the area revealed by the radar has just begun.

The first space use of the Synthetic Aperture Radar was on Seasat, NASA's oceanographic research satellite which orbited the Earth in 1978 and returned radar pictures of sea and land surfaces.

The radar survey of Guatemala and Belize was a joint endeavor by JPL and the Ames Research Center. The concept of using radar images for archeological research, was suggested by Dr. Bruce Dahlin, professor of archeology at the Catholic University of America in Washington, D.C. The expedition was funded by the Lende Foundation of San Antonio, Texas.

Experiments Selected for 1st Spacelab

NASA and the European Space Agency have selected 37 scientific experiments to be conducted on the first flight of Spacelab, scheduled for launch aboard the Space Shuttle in early 1983.

The experiments fall into five broad categories: atmospheric physics and Earth observations, space plasma physics, material sciences and technology, astronomy and solar physics, and the life sciences. Thirteen are sponsored by NASA; the remainder are the responsibility of the European Space Agency, a consortium of 11 nations. (Member nations of the European Space Agency are Belgium, Denmark, France, West Germany, Ireland, Italy, The Netherlands, Spain, Sweden, Switzerland and the United Kingdom.)

Dr. Thomas A. Mutch, Associate Administrator for Space Science, announced selection of the NASA-sponsored experiments in letters to the experiment developers, who are called principal investigators.

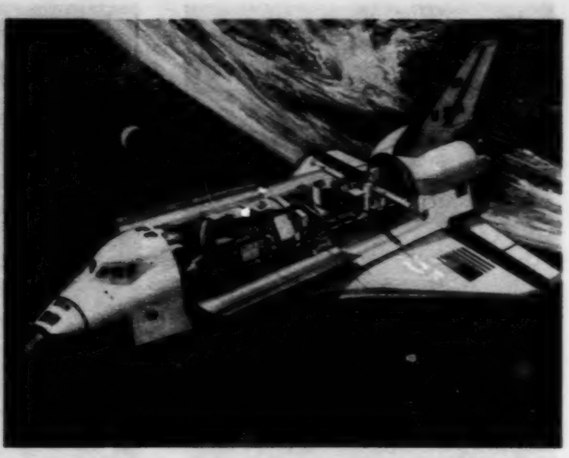
The selection was made from a list of experiments identified several years ago for definition and development. Three NASA-sponsored experiments and a major European Space Agency facility that were under development had to be deferred and will be assigned to subsequent Spacelab flights. The major limiting factor that prevented the selection of all experiments under development was mass, according to the Spacelab 1 mission manager. Each agency will be able to fly 1,392 kilograms of experiment equipment on the mission.

Spacelab is a flexible laboratory system that can be installed in the cargo bay of the Space Shuttle orbiter to provide an orbital research center for both astronauts and scientists. Unlike its predecessor, Skylab, this new system will not be left in space unattended. It will remain in the Shuttle for the duration of its mission, and be returned to Earth for refurbishment and preparation for the next mission.

The Spacelab facility is being designed and manufactured by the European Space Agency and a European contractor consortium. NASA will furnish the Space Shuttle and will manage the in-orbit activities with support from ESA.

Unique non-astronaut science crew members, called payload specialists, will provide support to the principal investigators in conducting their experiments in space. Five payload specialists, two Americans and three Europeans, are now training for the first mission. Two of this group, an American and a European, will fly aboard Spacelab 1. The other three will provide support to the mission in the Operation Control Center at the Johnson Space Center.

The Marshall Space Flight Center is Spacelab 1 mission manager for NASA.



Artist's concept illustrates one configuration of Spacelab in the orbiter's cargo bay.

Columbia Engines Due One-Burn Retest

The retesting of the Space Shuttle Columbia's three main engines, announced early in May, will consist of a single 520-second static firing for each engine.

Two test stands at the National Space Technology Laboratories, Bay St. Louis, Miss., will be used for the tests.

Officials scheduled reacceptance tests for the engines because of modifications made to the engines since the original acceptance tests were conducted in April and July 1979.

Testing is conducted by Rockwell International's Rocketdyne Division, Canoga Park, Calif., for the Marshall Space Flight Center which is responsible for development and testing of the Space Shuttle main engines.

The testing will be completed within weeks and is expected to have no effect on the timing of the Space Shuttle's first flight, anticipated in March 1981.

About six weeks before the first flight, the engines will be fired once again, for 20 seconds, on the launch pad.

Bonuses Go to 240 Executives

Cash performance awards have been presented to 240 NASA senior executives in the agency's top 520 jobs.

NASA is the third federal agency to announce these awards which are the result of NASA's implementation of President Carter's Civil Service Reform Act. In January, NASA received the Udall-Derwinski Award from the Office of Personnel Management for its leadership in implementing Senior Executive Service provisions of the Act.

The awards, ranging from 5 percent to 20 percent of base salary, were granted after review by a nine-person review board of senior career officials.

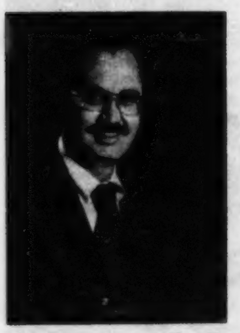
NASA Administrator Dr. Robert A. Frosch stated: "In enacting the Civil Service Reform Act, Congress recognized the importance of assuring that senior executives are accountable and responsible for their effectiveness and productivity.

"It recognized also the need for an executive compensation system designed to attract and retain highly competent senior executives and to reward exceptional accomplishments."

The performance awards made to NASA's senior executives total $1,371,938, which is approximately 6 percent of the Fiscal Year 1980 base salary of NASA's senior executives.

The Senior Executive Service, under the terms of the Reform Act, covers top level managers who may be given bonuses for high quality performance or reduction in grade or removal from government service if their work is unsatisfactory.

Phillips Awarded Fellowship



Dr. Donald H. Phillips, a physicist in the Laser and Spectroscopy Branch, Instrument Research Division, at the Langley Research Center, is the 1980-81 recipient of the Floyd L. Thompson Fellowship. The fellowship program, established in 1977 to encourage the development of research potential among the Langley staff, allows researchers who have demonstrated continued growth in research to spend up to 12 months at an educational or research institution. It is named in memory of Dr. Floyd L. Thompson, Langley Director from 1960 to 1968. Phillips will spend one academic year at the Applied Physics Division of Harvard University conducting research to improve theoretical methods used to investigate complex physical systems. The author or co-author of more than 30 technical papers, Phillips has received two Outstanding Performance Awards.

Petersen Named Langley Deputy

Richard H. Petersen has been named Deputy Director of the Langley Research Center by Langley Director, Dr. Donald P. Hearth.

Petersen fills the position formerly held by Oran W. Nicks, who left Langley to become the Executive Director of the Research Foundation of Texas A &M University in College Station, Texas.

Peterson, 45, leaves the position of Chief of the Aerodynamics Division of the Ames Research Center where he directed a 200-man team conducting research in aerodynamics and fluid mechanics in seven major wind tunnels.

Petersen graduated from Purdue University in 1956 with a bachelor's degree in aeronautical engineering, with highest distinction. In 1957 he was awarded a master of science in aeronautics by the California Institute of Technology. Petersen spent one year as a Sloan Executive Fellow at the Stanford Graduate School of Business (1972-1973) and one year on assignment to NASA Headquarters in Washington (1965-1966).

His initial work at Ames was in theoretical and experimental aerodynamics, particularly in the supersonic and hypersonic speed ranges. In more recent years he has directed research programs in aircraft noise, hydrogen-fueled aircraft, short take-off and landing aircraft and computer analysis of aircraft performance, as well as spacecraft studies and budget and facility planning. He has published a number of technical papers.

Petersen and his wife, Joandra, have two children —a son who is a college freshman and a daughter who is a high school junior.

Marshall 20 Years Old

This month marks the 20th anniversary of the Marshall Space Flight Center, created July 1, 1960, when NASA inherited the Wernher von Braun team of rocket pioneers from the Army Ballistic Missile Command.

Before joining NASA, to form the Marshall Center's management, engineering and scientific nucleus, this group had developed the Redstone rocket which had put America's first satellite into orbit and was soon to carry Astronauts Alan Shepard and Gus Grissom into space. But even more significant, the Marshall nucleus group brought to the fledgling space agency an already-moving program for the development of a family of giant launch vehicles that would come to be called Saturn.

In its first six years, the Marshall Center developed the largest rocket ever built, the Saturn V. This 36-story goliath launched the Apollo craft that carried 27 men around the Moon and 12 to the lunar surface.

While Marshall's traditional role has been that of developer of transportation systems, the center has gained a wide range of experience in spacecraft and experiment development as well. Marshall was responsible for the development of the Lunar Roving Vehicle, which changed our astronauts from lunar visitors to lunar explorers. The center developed Skylab, man's first orbiting laboratory, and played a key role in managing the space station's scientific payload. More recently Marshall managed the highly successful High Energy Astronomy Observatory series which, in addition to its scientific achievements, also pioneered common spacecraft design.

Today the Marshall Space Flight Center has a diverse mission. It has key roles in the development of Space Shuttle, with responsibility for the Main Engine, External Tank and Solid Rocket Boosters. Other current projects include Spacelab development, the management of the first three Spacelab missions, and the development of Space Telescope.

The center is heavily involved in materials processing in space; it is charged with responsibility for NASA's Inertial Upper Stage; it is working on a Teleoperator Maneuvering System for Shuttle and a 25-kilowatt Power System. Studies are underway at Marshall to explore the technology needed for such things as space platforms and large structures in space, Solar Electric Propulsion Systems and future launch vehicles. The center provides technical management for more than 1000 Department of Energy solar heating and cooling demonstration and development sites throughout the country and is working with the Tennessee Valley Authority to explore the feasibility of producing commercial gas from America's large supplies of coal.

The anniversary was marked in Huntsville with an employee picnic and a ceremony at which Center Director Dr. William R. Lucas paid tribute to the more than 1,000 "charter members" of the center still at work on today's projects.

Large Antenna Studies Planned

The Marshall Space Flight Center has received proposals from several companies interested in performing definition studies for a space flight experiment to demonstrate, in low Earth orbit, the characteristics and performance capabilities of large space antenna systems. Such systems, if put into wide use, could greatly advance communications, radar and radiometry operations via satellites.

An evaluation of future requirements in these fields has shown that large antenna systems may be the answer to problems that now prohibit expansion of satellite communications, Earth resources surveys, weather research and other services.

Marshall will select two firms to conduct parallel 12-month studies.

Space Disposal of Nuclear Waste Studied

The Boeing Aerospace Co., Seattle, Wash., has been awarded a Marshall Space Flight Center contract to study and analyze systems concepts for the possible disposal of nuclear wastes in space.

The Marshall contract action supports the Department of Energy's program to develop technology for managing radioactive wastes in a safe and environmentally acceptable fashion. The space disposal option could supplement Earth disposal by removing from Earth the long-lived radionuclides which remain radioactive over tens of thousands of years.

A joint NASA/Department of Energy working group has prepared a preliminary four-year concept for a development and evaluation study plan detailing the activities necessary to reach an assessment of the space disposal option. The $296,000 Boeing study, to be completed by December, will provide input for the first year of activities in this area.

If the program plan is adopted, the Marshall Center will continue space system studies over the next four years, while the Department of Energy will be conducting parallel studies in the areas of nuclear waste systems, associated domestic and international concerns, and related assessments.

Studies of space systems concepts will include nuclear waste payload protection approaches, identification of space destinations, options for type of space transportation and launch sites, and payload retrieval techniques.

Association to Guide Student Project

The National Science Teachers Association has been selected for negotiation of a NASA contract to manage the Shuttle Student Involvement Project.

The project is a nationwide competition to be conducted annually among secondary school students for scientific and engineering experiments to be performed on a "space available" basis aboard the Space Shuttle. The Shuttle is expected to become operational in 1982.

NASA Administrator Dr. Robert A. Frosch said, "The vitality of NASA depends heavily on an infusion of fresh ideas. Therefore, our connection with students is extremely valuable to us and is an important part of our program."

Competitions will be conducted in the fall each year leading to the selection of winners the following spring. The association will formulate rules and define 10 regions from which semifinalists will be selected. It also will distribute announcements, devise entry/application forms and manage the actual competition. The group will work closely with Dr. Glen Wilson, NASA special assistant for student activities, in formulating rules and selecting winning entries.

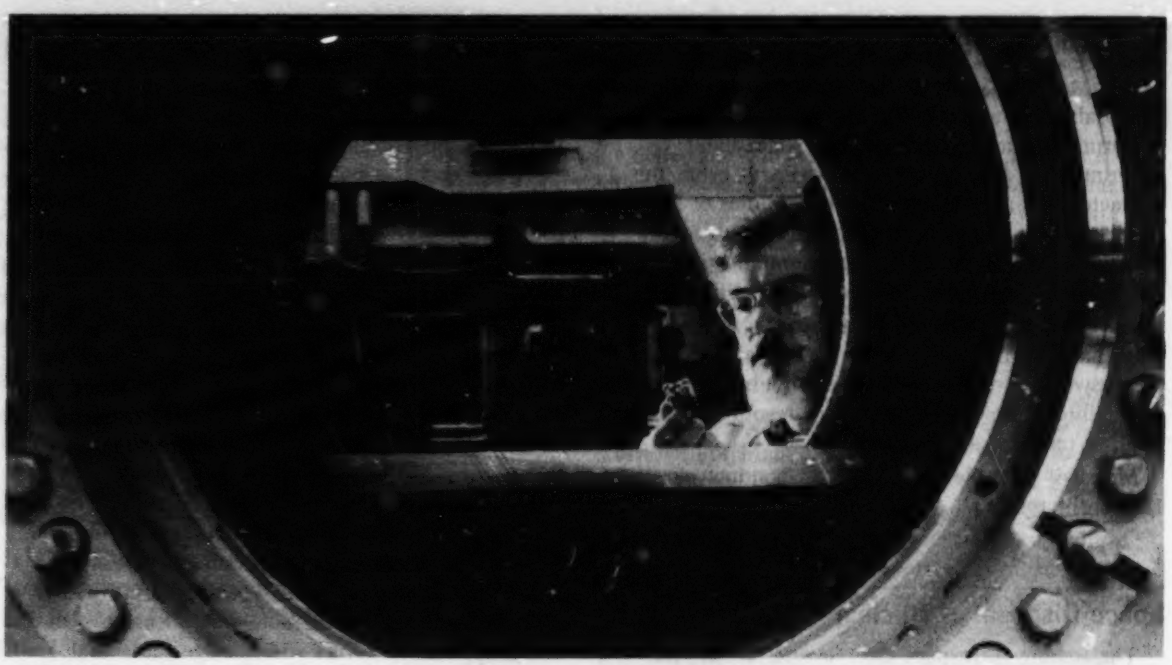
Twenty semifinalists will be chosen in each of the 10 regions. Each region will hold a seminar at which semifinalists will discuss their proposals. Following these, up to 10 proposals in each region will be chosen for final judging. The 10 final winners will be named from the pool of approximately 100 regional choices. NASA retains final decision on whether it is possible to fly a particular experiment or accommodate winning students in some other fashion.

Student winners may also receive other awards such as a trip to the Kennedy Space Center in Florida to discuss their projects with other students, professional scientists and NASA officials.

To broaden participation in the program, NASA plans to ask outside groups to sponsor the development and post-flight analysis of the student experiments.

The student project is part of a long-standing and continuing NASA program to involve the nation's secondary school students in creative scientific activity. A similar competition was conducted prior to the Skylab mission in 1973.

A program to involve college-level students is under consideration.



Shuttle Boost Module Tested—This wind tunnel at the Marshall Space Flight Center has been used over the past 24 years in scale model tests of such vehicles as the Redstone rocket, Saturn and Skylab and now is helping engineers determine the forces and loads the Space Shuttle will experience with a Liquid Boost Module attached. The boost module, now under development, will increase thrust for the Shuttle through the addition of Titan engines and tanks. The module will be needed in the mid-1980s to increase the cargo-carrying capability of the Shuttle for near-polar-orbit missions launched from the West Coast. The instrumented Shuttle model shown is subjected to air flows from 322 kilometers per hour to five times the speed of sound and pressures as high as 6.2 kilograms per square centimeter. Paul Ramsey, technical monitor for the Marshall tests, holds replica of the proposed boost module beside viewing port of the wind tunnel.

Orbital Flight Test Program Extended

The date for completion of the first four Space Shuttle orbital flight tests has been extended to April 1982, making it necessary to reschedule the first operational flight of the Columbia, STS-5, from March 1982 to September 1982.

The decision to extend the flight test program beyond September 1981 and to reschedule STS-5 is the result of several factors, the major one being continuing engineering assessment and improvement of the Thermal Protection System.

Additionally, it was felt that there should be more time allowed for necessary engineering tasks during the orbital flight tests, and that a concerted effort should be made to effect a smooth and structured transition from the orbital flight tests to the operational phase of the Space Shuttle Program.

The first operational flight will launch the Tracking and Data Relay Satellite-A into a geosynchronous orbit according to the Space Transportation System operations manifest currently being revised. Changes in the operations manifest have been coordinated with the Department of Defense, a major user of the Space Shuttle. The readjusted operational launch schedule is being discussed in detail with other Shuttle users.

During the transition to full Space Shuttle operations, NASA will employ the Delta 3910 and the uprated Delta 3920 launch vehicles. In addition to NASA, other organizations expected to use these launch vehicles include Telesat of Canada, Indonesia and Hughes Aircraft.

To provide timely launches and to accommodate 3900-series Deltas for these and other Delta users, modification of Launch Complex 17-B at the Kennedy Space Center is being considered.

March 1981 is now the most probable time for first launch in the Space Shuttle (STS-1). The completion of the Thermal Protection System and its mechanical integrity remain the prime technical concern of the Shuttle development program.

HEAO Management Office Terminated

The organization within the Marshall Space Flight Center which managed the successful three-mission High Energy Astronomy Observatory program has completed its primary assignment and has been officially abolished, according to Marshall Director Dr. W. R. Lucas.

The Space Science Projects Office performed its assignment "essentially on schedule and within the resources budgeted," Lucas stated in a written announcement. "The highly successful completion of this project is due largely to the continuous and outstanding dedication and efficiency of the HEAO management team," Lucas added.

Dr. Fred A. Speer served as manager of the Space Science Projects Office from its inception in 1972. Prior to that, he headed the HEAO Project Office, established in 1971. Speer is now manager of the Space Telescope Project Office.

Responsibility for managing Marshall's remaining responsibilities in the high energy astronomy project is being transferred to the center's Special Projects Office headed by J. C. Swearingen. The project was designed to provide scientists with a capability to study X-rays, gamma rays and cosmic rays emitted by stars and star-like objects through the universe.

HEAO-1, launched in 1977, scanned the skies for X-ray and low-level gamma-ray sources for 17 months—the expected lifetime was only six months—before it reentered the Earth's atmosphere and was destroyed March 14, 1979. HEAO-2, launched in November 1978 and carrying the largest X-ray telescope ever built, has completed its scheduled 12-month mission. It is projected to remain in operation for at least another year. HEAO-3, launched Sept. 20, 1979, recently completed its basic six-month mission to scan the entire universe for cosmic-ray particles and gamma-ray photons. The observatory is expected to have a lifetime of up to 13 more months, providing a huge bonus of data gathering for scientists.

Contractors Reimburse NASA for Research

In what could be a unique payback plan, the Lewis Research Center is receiving checks totaling approximately $200,000 from the General Electric Co. and from Pratt & Whitney Aircraft, a division of United Technologies Corp. The checks represent the first installments under a plan whereby both companies will reimburse the federal government for its costs associated with advanced jet engine research and development.

Installments will be paid annually, for as long as 10 years, until Lewis is fully reimbursed for its share of research and development costs. Actual amounts will be based each year on sales by Pratt & Whitney and General Electric of their new turbofan engines having components whose concept and design were developed under the Lewis Engine Component Improvement Project, a major element of NASA's Aircraft Energy Efficiency Program. There are two categories of sales: improved engines to aircraft manufacturers and improved components to airlines for installation on existing engines.

Lewis-sponsored research affected by the payback plan is directed toward improving efficiency and fuel economy of the Pratt & Whitney JT9D and JT8D and the General Electric CF6 turbofan engines. These are used in jetliners such as the McDonnell Douglas DC-10 and DC-9 and the Boeing B-747, B-737 and B-727.

Contractor News

McDonnell Douglas Astronautics Co., of Huntington Beach, Calif., received a $70,072,000 follow-on fixed-price incentive contract for Delta expendable launch vehicle services. The contract calls for continuation for two years of launch services work performed by the company for the past 19 years for Delta, including mission-peculiar vehicle changes, checkout and launch.

Link Division of the Singer Co. signed a supplemental agreement with the Johnson Space Center valued at $16,293,571 covering additional maintenance, modification and operational support of the center's simulation complex through Jan. 31, 1981.

Charles Stark Draper Laboratory, Inc., of Cambridge, Mass., was awarded a $12,931,464 cost-plus-fixed-fee contract by the Johnson Space Center to develop Space Shuttle orbiter avionics software.

Planning Research Corp., of McLean, Va., was selected for negotiation of a five-year contract to provide business data processing support services to the Langley Research Center. Value of the cost-plus-award-fee contract beginning July 1, will be about $6.9 million and includes a significant subcontract with a minority-owned business.

Universities Space Research Assoc., of Columbia, Md., was awarded a cost-plus-management-fee contract to continue management and operation of the Lunar and Planetary Institute, Houston, Tex. Total cost for the two-year period, through March 31, 1982, is $4,292,700. The Institute is adjacent to the Johnson Space Center.

Beech Aircraft Corp., of Boulder, Colo., was awarded a $2,504,750 Kennedy Space Center contract to furnish a fuel cell servicing system to support Space Shuttle launch operations at Vandenberg Air Force Base, Lompoc, Calif. Beech Aircraft will install a system of tanks and piping on the launch pad to supply the orbiter with liquid oxygen and hydrogen shortly before launch. The work is to be completed by Nov. 1, 1981.

McDonnell Douglas Astronautics Co., of Huntington Beach, Calif., and TRW, Inc., of Redondo Beach, Calif., have been selected by the Marshall Space Flight Center to receive parallel contracts of about $1 million each for design definition studies of a 25-kilowatt power system for NASA's Space Transportation System. The system is to provide 25 kw of power from solar energy.

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Amal M. Salama, Caltech/JPL	Method of mitigating titanium impurities effects in P-type silicon material for solar cells	4,201,622	NRO/JPL
William R. Rosier, Jr., George G. Volk, Servo-Air Inc., Edwards, Calif.	A portable device particularly suited for use in starting air-start units for aircraft	4,204,154	DFRC
Roger A. Craig, Huw O. Pritchard, NASA/Ames	Reduction of nitric oxide emissions from a combustor	4,204,402	ARC
Hill M. Walker, Max H. Sharpe, William G. Simpson, NASA/Marshall	Cork-resin ablative insulation for complex surfaces and method for applying the same	4,204,899	MSFC

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January 17	Atlas Centaur	ETR	DOD Navy. Reimbursable.
SMM-A	February 14	Delta	ETR	NASA. Scientific Solar Maximum Mission.
NOAA-B	May 29	Atlas-F	WTR	NOAA Weather. Reimbursable. Launch vehicle failed.
Navy-20	July	Scout	WTR	DOD Transit. Reimbursable.
GOES-D	August	Delta	ETR	NOAA Weather. Reimbursable.
Navy-21	October	Scout	ETR	DOD Transit. Reimbursable.
SBS-A	October	Delta	ETR	Satellite business systems. Reimbursable.
FLTSATCOM-D	October	Atlas Centaur	ETR	DOD Navy. Reimbursable.
Intelsat V-A	November	Atlas Centaur	ETR	Intelsat communications. Reimbursable.

Did You Know?

At the end of a short corridor in the basement of the Marshall Space Flight Center's 10-story headquarters building stands a massive, bank-size vault—shut tight and double locked. Behind the heavy, steel door there are no piles of gold bullion or government secrets. Instead, stacked neatly on rows of shelves, are plastic containers filled with fragments of metal and other substances, many no bigger than a baby's fingernail. On other shelves are somewhat larger gadgets or parts of gadgets. It all may look like junk, but treasure it is; space treasure. The cool, crypt-like room contains more than 100 pieces of equipment, hardware, and specimens that have ridden into space or have been formed aboard such historic flights as Apollo 14, Apollo-Soyuz and Skylab. "Once something has been in space, it is the type of material you really need to keep a tight control on," explained J. D. Horne, chief of Marshall's Property Management Division. "These objects have historical significance, and some have continuing research value," he explained.

"One of the truly tantalizing ideas" emerging from the International Ultraviolet Explorer Satellite's observations of hot and cold stars "is that magnetic fields and rotation together have much to do with creating the unexpected hot gas we are seeing around stars," reported Dr. Anne Underhill, Goddard Space Flight Center Senior Scientist, at a scientific colloquium at the center. Other investigators found data contributing to the evidence (discovered by ground-based astronomers) that "twin" quasars lying close to each other in the sky actually were two images of the same object. The light waves reaching Earth were being bent around an intervening, massive elliptical galaxy acting as a gravitational lens in a fashion predicted from Einstein's general theory of relativity. Launched on Jan. 26, 1978, the 1,700-kilogram spacecraft is in a synchronous orbit, which enables it to be in continuous contact with either the American or European ground station which controls its operation. It is a joint project of the United States, United Kingdom and the European Space Agency. Astronomers come to one of the ground stations, at Goddard and Vilspa, Spain, and use the spacecraft much like a ground-based telescope. However, they observe the universe in the ultraviolet rather than with visible light or radio waves as from the ground.

Idea Clearinghouse, an internal voluntary pilot program to spread the word on good management ideas, this month cites Goddard Space Flight Center's Automated Accrued Cost System which was designed through the group effort of Phil Snyder, Don Henderson, Don Romano and Linda Price. It is a proven method of reducing the time spent by cost analysts in manual preparation of monthly contractor financial management reports. The system is especially useful for multiple job order cost-type contracts which typically have hundreds of tasks to monitor. On one such contract Goddard estimates a savings of 1,000 man-hours a year. The contractor submits the required monthly report on a tape. The software system extracts the pertinent cost data automatically in the formats required for timely financial and manpower status reports. If you would like to know more about this idea call Goddard's Phil Snyder at 301/344-5476. For information on Idea Clearinghouse, contact Code NSM at Headquarters.

A unique summer enrichment program aimed at exposing 22 bright minority high school students to the world of science and engineering has begun at the Lewis Research Center. The Research Apprenticeship Program in Science and Engineering is part of a federal plan to employ 1000 such students at universities and federal research centers throughout the country. "It is hoped that the pairing of students with engineers and scientists will stimulate these gifted young people to seek out science and engineering concentrations later at the college level," said Harrison Allen, Jr., who manages the program for Lewis. About 100 applications from suburban and Cleveland schools were being screened to select the students to take part in the Lewis program.

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Another Dividend from Air and Space

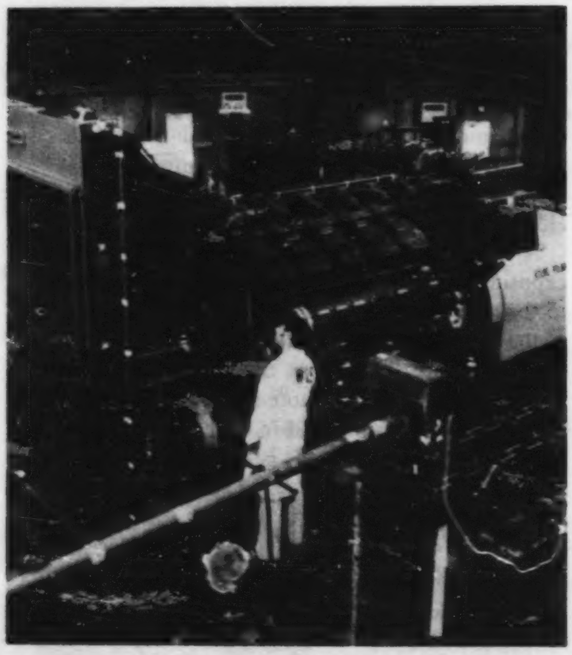
Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

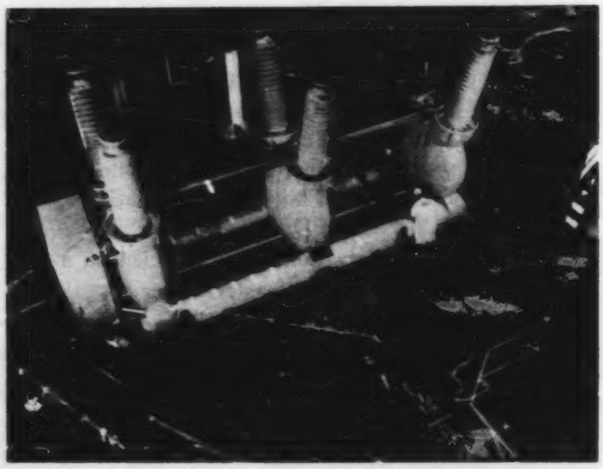
Earthquake Treatment

During NASA's Apollo Program to put men on the Moon, it was necessary to subject the mammoth Saturn V to extremely forceful test vibrations to assure the launch vehicle's structural integrity in flight. NASA assigned vibration testing to Scientific Services and Systems Group of Wyle Laboratories, Norco, Calif. Wyle-3S*, as the group is known, built a large facility at Huntsville, Ala., and equipped it with an enormously forceful shock and vibration system.

The Saturn V no longer is in service, but Wyle-3S has found a variety of spinoff uses for its vibration facility. It is now being used to stimulate earthquake effects on various kinds of equipment intended for nuclear power generation. Government regulations require that such equipment demonstrate its ability to survive earthquake conditions. In left photo, Wyle-3S is preparing to test a 25-ton diesel generator for standby use at a nuclear plant. Being readied for test in the right photo is a large circuit breaker.

In addition to earthquake testing, the company has adapted the shaking technology to simulate dynamic transportation environments in order to evaluate effects on railway cars, rail and highway-transported cargoes and truck refrigeration units. A variation of the technology permits non-destructive testing of highway pavements.





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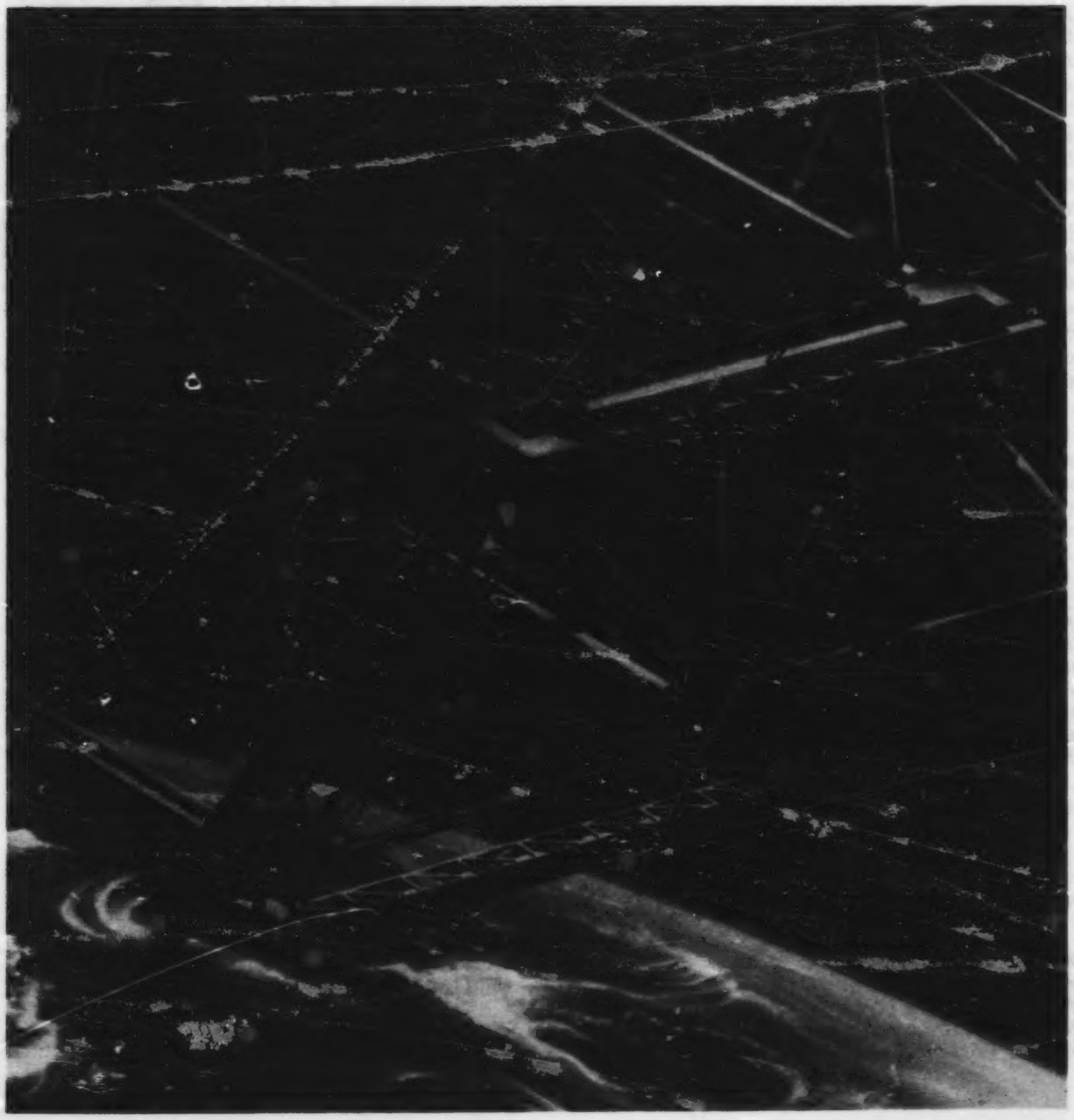

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Space Structures in the Making— Artist's concept of an automatic assembly system that in two days could construct an outer space platform the size of three football fields. Lockheed Missiles & Space Company is conducting a feasibility study of the system under contract to NASA's Langley Research Center in Hampton, Va. The electrically-driven assembly machine permits lateral as well as backward movement. The machine would move along the edge of the platform, installing columns and node joints along the way. Tapered half-columns would be loaded onto the beams of the assembler where the large ends of two half-columns are snapped together for installation into the tetrahedral structure by simple insertion mechanisms. Node joints, necessary to connect the columns that form the platform, are delivered as required from canisters appropriately located on the assembly machine. The assembly machine and the columns would be delivered to space in the Shuttle Orbiter's cargo bay. About 5000 columns could be delivered on each flight.

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Letter from Washington

Dear Colleagues:

During the second week of last June, I had the intriguing and stimulating experience of participating in the New Directions Symposium at Woods Hole, Massachusetts. A few comments on the Symposium and its work may be of interest.

The Symposium was sponsored by the NASA Advisory Council and several members of the Council attended and chaired various working groups. John Naugle chaired the entire meeting. The purpose of the week's work was to explore for new directions in space programs beyond what is presently planned. Four specific areas were examined: the human role in space; life sciences; applications; and solar physics and solar-terrestrial interactions. There was also a fifth, catch-all area to follow up on ideas left over from last year's meeting and to provide a hearing for any other interesting ideas which might crop up outside of the formal four.

The Symposium was attended by about 50 people who were divided almost equally between the five working groups. Attendees were selected by an *ad hoc* committee of the Advisory Council and represented a broad range of scientific and other disciplines from government, industry and the universities. At one end of this spectrum were highly focused solar physicists and at the other end such perceptive generalists as author James Michener, demographer Kingsley Davis, and Dennis Flanagan, editor of *Scientific American*.

Predictably the ideas developed and the topics considered were as wide-ranging as the intellectual leanings of the participants. Some samples:

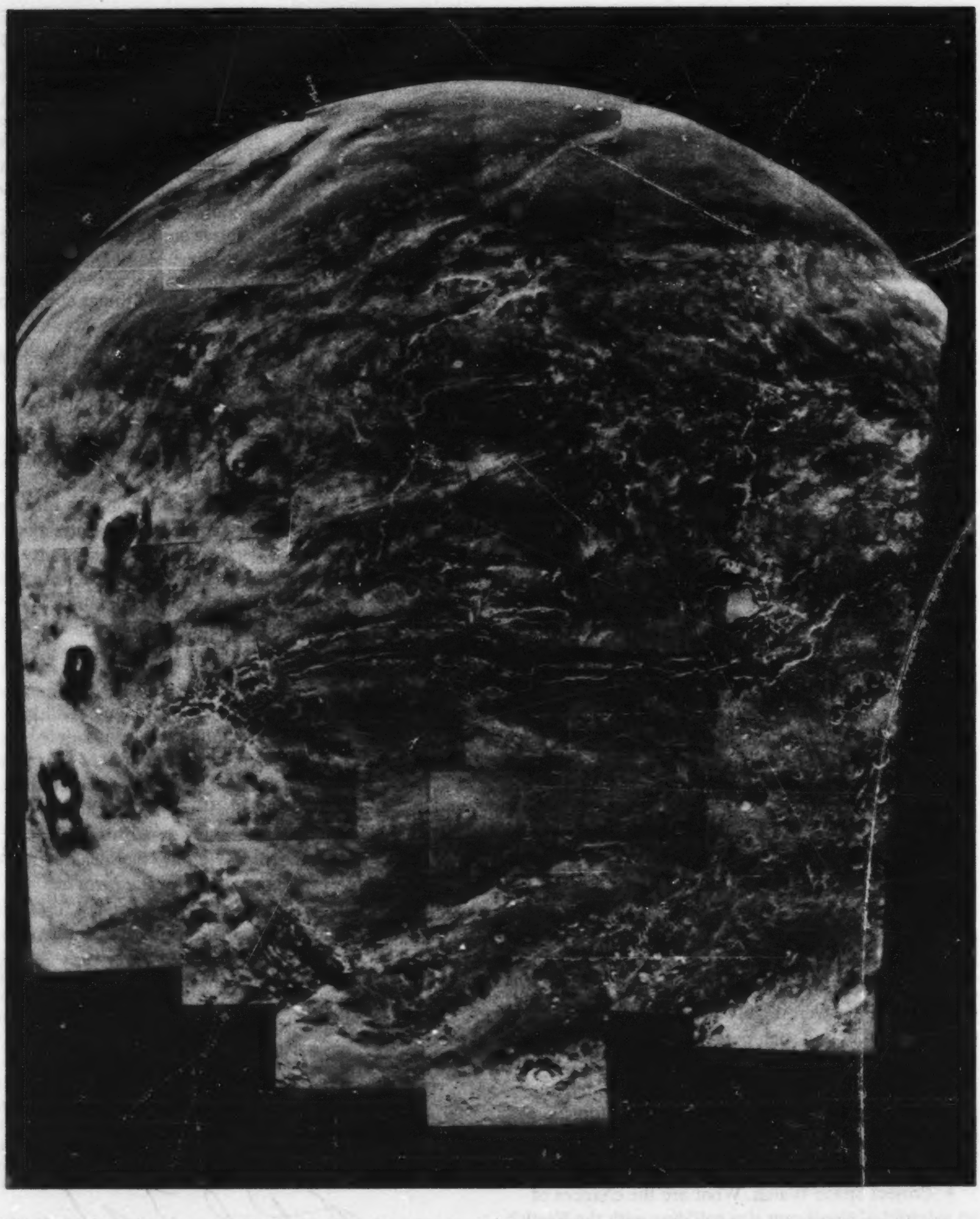
- Project Space Watch. What are the chances of an asteroid of significant size colliding with the Earth? What is NASA's role in (1) assessing the probability, and (2) identifying and tracking large earth-orbit-crossing asteroids? If an asteroid were determined to be on a collision course, what kinds of things could we possibly do to deflect it?
- Intriguing and ingenious ideas were developed on how to use existing spacecraft systems in new ways and how to extend existing systems in relatively straightforward ways to obtain measurements which would greatly improve our ability to predict weather and climate.
- Similarly bright ideas surfaced in the area of solar physics, including intriguing concepts for relatively inexpensive (as well as very expensive) spacecraft able to take measurements of the sun of significant scientific value which are not presently possible.
- The door was opened on a whole new investigative field—the myriad biological and chemical cycles between atmosphere and ocean.

These and other results of the Symposium will be reported in an Executive Summary to be circulated to the attendees, the members of the Advisory Council and NASA management. The working papers of the various groups will be available on request to program offices with a need to know details of the ideas and concepts concerned. Eventually the ideas with the highest potential will come to me in the form of recommendations from the Advisory Council for further study and possible incorporation in future programs.

It was a challenging and rewarding week and some of the ideas generated may well affect our lives in the years ahead.

Sincerely,

Robert A. Frosch



This mosiac of 102 photos of Mars taken Feb. 22, 1980 by NASA's Viking Orbiter 1, shows several prominent Martian features. Valles Marineris, as long as the North American continent from coast to coast, stretches across the center. Three huge volcanoes of the Tharsis are at left: Arsia Mons, Pavonis Mons and Ascraeus Mons (from south to north). A sharp line, either a weather front or an atmospheric shock wave, curves north and east from Arsia Mons. This is the first time a feature like this has been seen.

Viking Discovers Martian Phenomena

Types of weather activity rarely or never before observed on Mars have been discovered in pictures taken by NASA's Viking Orbiter 1 spacecraft. The unusual Martian meteorological phenomena were found in images taken on an exceptionally clear Martian day on Feb. 22. Several prominent features and at least two meteorological anomalies are visible in a mosaic of 102 frames taken that day. The photomosaic is probably the best wide-area view of the Mars surface yet obtained.

The most remarkable weather activity in the mosaic appears as a sharp, dark line which curves north and east from the huge volcano Arsia Mons in the Tharsis Ridge. Scientists believe this line is either a weather front or atmospheric shock wave. Nothing like this weather phenomenon has ever been seen before on Mars.

The second unusual weather activity consists of four small clouds that hover just north of the Lowell crater. Though two of the clouds are so close together as to be almost inseparable even in high enlargement, four clearly separate cloud shadows are cast on the planet surface. The largest cloud is about 32 kilometers (20 miles) in length. Judging from the distance between the clouds and shadows, the clouds float at an altitude of nearly 28 km (17 mi). The shadows, which are cast to the south of the clouds, indicate that the photographs near the center of the mosaic were taken close to noon, local Martian time. Distinct cloud pattern shadows are rarely apparent on the face of Mars.

Viking Orbiter 1, launched Aug. 20, 1975, entered Mars orbit June 19, 1976. It is nearing the end of four years of planetary operation, but continues to transmit an average of 30 pictures a day to controllers at the Jet Propulsion Laboratory, Pasadena, Calif., which manages the Viking project for NASA.

NASA Satellite Records Solar Flare

Scientific instruments aboard NASA's Solar Maximum Mission spacecraft have recorded a 40-minute burst on the Sun's surface which may have resulted in the most significant observations ever made of a solar flare. The flare—covering more than 5.2 billion square kilometers (2 billion square miles) of the Sun's surface—was measured by six instruments aboard the spacecraft on May 21.

Solar flares are sudden, violent explosions in the Sun's atmosphere—an eruption of heat and light that sends shocks and solar gases into space, frequently toward Earth. The intense electromagnetic radiation generated from the flare so disturbed the Earth's ionosphere that radio communications over a broad band of frequencies were lost for more than a half-hour, according to scientists at NASA's Goddard Space Flight Center in Greenbelt, Md. The flare also created a nine-hour geomagnetic storm but it had little other effect on Earth, they reported.

For the first time, the spacecraft's telescopes were able to be focused on the hottest part of a giant flare, indicating—if thermal interpretations are correct—that the flare core temperatures may be more than 56 million degrees Celsius (100 million degrees Fahrenheit). Normal surface temperatures on the Sun range from 4,400 to 5,500 degrees C (8,000 to 9,900 degrees F).

Other measurements made by the spacecraft may shed new light on a controversy that has divided solar scientists for a long time: Do flares resemble the hot, thermal flash that accompanies a blown fuse, or do they resemble the more exotic, non-thermal phenomena seen in laboratory accelerators? The new ingredients that will make scientists take a new look relate to the apparent lack of acceleration of protons in the flare's magnetic field. Previously, scientists believed every major solar flare accelerated protons.

Experiments aboard the spacecraft are expected to tell scientists how solar magnetic fields confine the ionized hydrogen gas until temperatures go above 17 million degrees C (30 million degrees F). This data may in turn provide information on possible new energy mechanisms.

In addition to the scientists at Goddard, other investigators involved in the project include researchers from industry, research institutes and universities. Scientists from eight foreign nations are participating directly in the project, including representatives from Great Britain, France, Germany, Italy, Australia, The Netherlands, Argentina and Japan. Overseen by the International Council of Scientific Unions, more than 400 scientists at 60 institutions worldwide are cooperating with the mission through the Solar Maximum Year—the peak of the 11-year cycle of flares on the Sun.

The Solar Maximum Mission spacecraft was launched from NASA's Kennedy Space Center, Fla., last February to coincide with the peak of the 11-year cycle. The spacecraft is circling Earth at a distance of 500 kilometers (311 miles).

Earth's Magnetic Field Changing

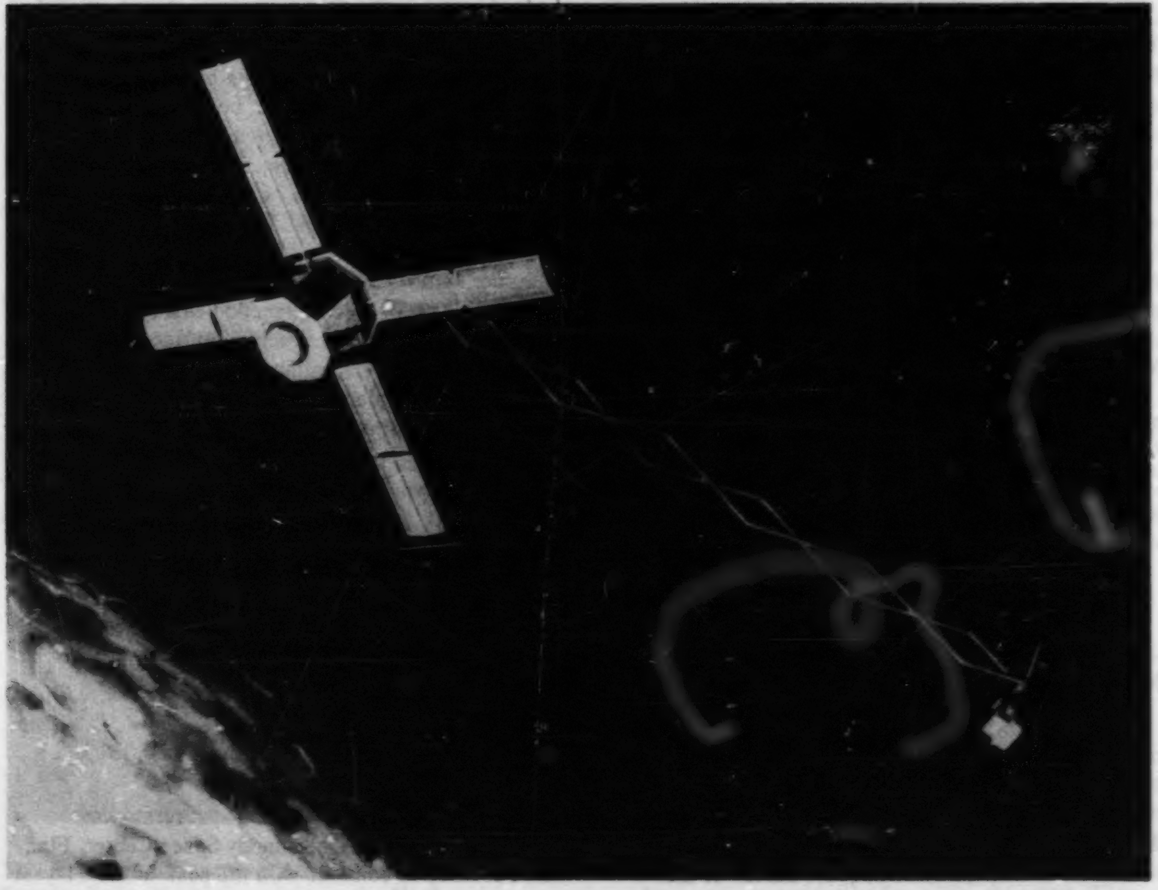
Magsat, a small relatively inexpensive NASA satellite, has provided scientists with data to make the most accurate maps ever of the Earth's magnetic field. The satellite was equipped with two magnetometers, one to measure the magnitude and the other the direction of the Earth's magnetic fields. Initial data from these investigations, published by scientists at Goddard Space Flight Center, Greenbelt, Md., further confirmed the changing nature of the Earth's magnetic field.

Using data gathered from the satellite, scientists have compiled models, or maps, of the Earth with contour lines that delineate regions of abnormal magnetic intensities. It is believed that these magnetic anomalies are related to movement of the Earth's crust and may provide important clues to geologists in search of new mineral and petroleum deposits.

The principal user of Magsat data, the U.S. Geological Survey of the Department of the Interior, has cooperated closely with NASA in setting mission objectives and is participating in the data analysis. The Survey will use Magsat's data to update the agency's publication of magnetic field charts and maps in 1980-81 for navigation and geological use.

Scientists from the United States and eight other countries—Australia, Brazil, Canada, France, India, Italy, Japan and the United Kingdom—are studying Magsat data in 32 investigations in six general categories: geophysics, geology, field modeling, marine studies, magnetosphere/ionosphere and core/mantle studies.

The 277-kilogram (611-pound) satellite, launched in October 1979, re-entered the Earth's atmosphere and crashed into the Norwegian Sea at approximately 3:30 a.m. EDT on June 11, according to a report from the North American Defense Command.



Magsat (Magnetic Field Satellite), the first spacecraft specifically designed to measure the near-Earth magnetic field and crustal anomalies.

Ring May Have Surrounded Earth

A ring similar to the rings surrounding Saturn today may have existed around Earth 34 million years ago, according to a scientist at NASA's Goddard Space Flight Center in Greenbelt, Md. Dr. John A. O'Keefe, of Goddard's Laboratory for Astronomy and Solar Physics, calculates that the ring, composed of tektites (glass meteorites), lasted one to several million years. The shadow of the ring on Earth's surface caused dramatic climatic changes in the temperate zones.

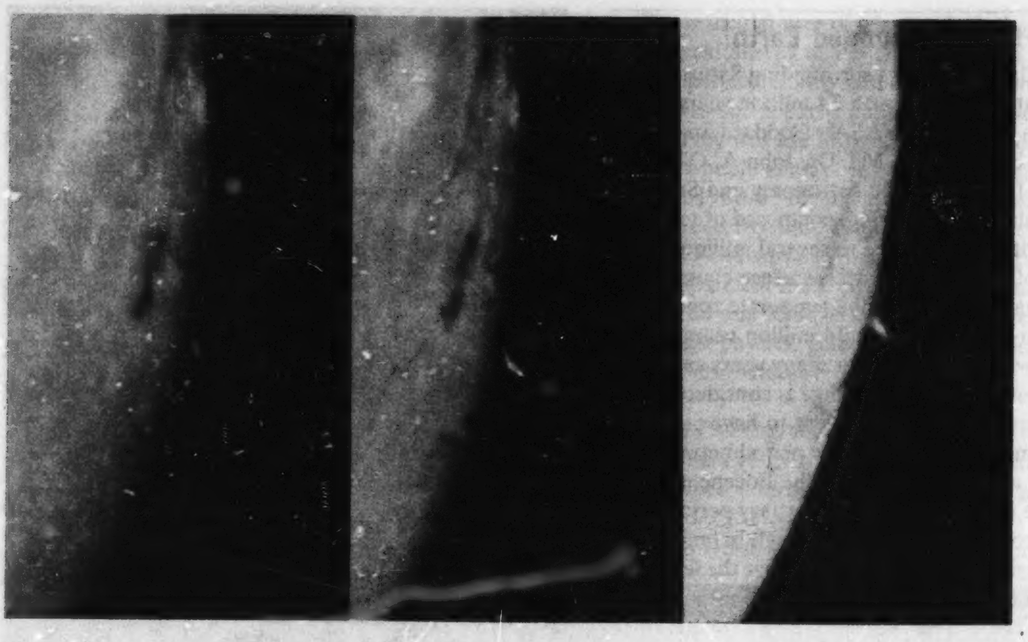
The sudden climatic change 34 million years ago has been known to geologists for many years as the terminal Eocene event. This change is considered to be the most profound climatic event to have occurred during the entire Tertiary period between 65 million and 2 million years ago. (The Eocene era represents the earliest part of the Tertiary period in the Earth's geological history.) Through botanical studies, geologists already had found that the temperature changes occurred at the end of the Eocene but, until now, there has been no acceptable explanation for the occurrence, according to O'Keefe. During the terminal Eocene event, he explained, winter temperatures in the northern hemisphere dropped approximately 20 degrees Celsius (36 degrees Fahrenheit).

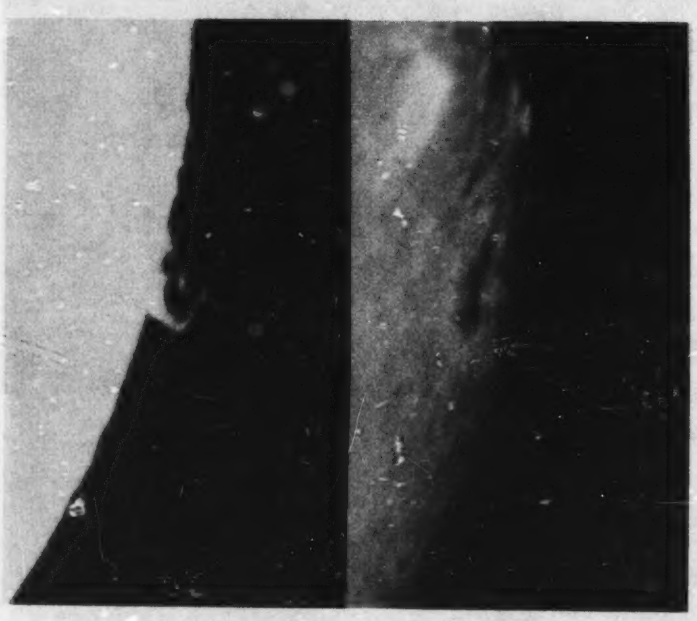
The basis for O'Keefe's belief lies in the fact that the biological changes coincide quite accurately with a massive fall of tektites from outer space. While the precise origin of the tektites has not been established, O'Keefe thinks that they might have come from an eruption on the Moon. Studies of the tektites, he said, show that some of them have similarities with rocks brought back from the Moon by American astronauts in the NASA Apollo program. Whatever their source, these tektites crashed into the Earth, leaving a path, or strewn field, extending at least halfway around the Earth, from the eastern United States westward across the Pacific to the Philippines.

O'Keefe suggests that the tektites that missed Earth went into orbit around our planet and organized themselves into a ring like the rings around Saturn. Once formed, the ring blocked out the rays of the Sun in the northern hemisphere in the winter, due to the Sun's location below the plane of the equator. The shadow cast by the rings resulted in the lowering of winter temperatures.

The ring disappeared, O'Keefe believes, when forces in space, such as the pressure of sunlight or the drag of the atmosphere, pulled the particles out of the ring. They were pulled either downward into the atmosphere, where some burned up and others fell to Earth, or upward into space away from the Earth.

Voyager Day at Headquarters—A day of activities commemorating the Voyager Jupiter encounter was held on June 18 at NASA Headquarters. Nineteen scientific papers in four topic areas—the atmosphere; the magnetosphere, flex tube and radio emission; Io and the plasma torus; and Saturn—were presented during a daylong Voyager seminar. In addition, a BBC film entitled "Encounters with Jupiter," a 60-minute documentary describing the results of Voyager's mission to Jupiter was shown for Headquarters employees. NASA's Administrator, Dr. Robert A. Frosch (shown above) activated a Voyager display case whose primary feature is a white-light hologram of Jupiter depicting a three-dimensional rotational movie taken by Voyager I on its approach to Jupiter in March 1979. One complete rotation of the hologram corresponds to one complete Jupiter rotation (or Jupiter day). Additional features of the display are numerous awards presented to the Voyager program.





These views of spectacular magnetic loops on the southwest limb of the Sun were taken May 1 by observers using the H-Alpha telescope at the Marshall Space Flight Center's observatory. The loops reached an altitude of about 45,000 kilometers (28,000 miles). Times (Eastern Daylight) of the pictures were: (top left to right) 5:19 p.m., 5:23 p.m., and 5:31 p.m.; (bottom left to right) 5:37 p.m. and 5:56 p.m.

Giant Solar Loops Detected

Two observers at the Marshall Space Flight Center, Huntsville, Ala., captured on film May 1 giant magnetic loops caused by a flare on the surface of the Sun. These loops were so large—about 45,000 kilometers (28,000 miles) high—that the Earth could have sailed through them with room to spare. The images obtained at Marshall will be used as comparison data valuable to the Solar Maximum Mission because that spacecraft was observing the same area of the Sun at the same time.

Jesse Smith, of MSFC's Space Sciences Lab, was checking real-time X-ray data coming in by computer from the Geostationary Operational Environment Satellite (GOES) when he noticed signs that a flare was occurring somewhere on the Sun. At that time the Sun was hidden by clouds, and the flare would not have been visible. However, hopeful that the solar cloud cover would lift, he rushed his X-ray data to Dr. Mona Hagyard at MSFC's observatory.

Just as he arrived the clouds parted, and the Sun came out. "We were then able to spot the loops forming on the southwest limb of the Sun," he said. Hagyard and Smith photographed the event at intervals through the H-alpha telescope for more than one hour. "The flare took place behind the Sun," Smith explained, and the loops formed high above the limb, the particles falling back spectacularly along the magnetic 'legs' of the loops."

Smith said photographing images of solar loops is "very rare" due to a number of factors. Loops usually occur months apart; they are often not aligned so that they are visible from a broadside perspective; clouds often cover the Sun while loops occur; sometimes the event happens when it is nighttime at the observer's site; and sometimes the observers are occupied with other matters and fail to catch the event.

The group of observers at Marshall is providing ground based data in support of the Solar Maximum Mission.

Largest In-Space Metal Produced

NASA launched its seventh Space Processing Applications Rocket (SPAR) May 14 from the White Sands Missile Range, N.M. The rocket carried a payload of three materials-processing in-space experiments and was one of a series of SPAR flights that were initiated in 1975 by the Marshall Space Flight Center, Huntsville, Ala. The flights offer materials-processing scientists an interim opportunity, between the Apollo and Shuttle programs, to perform additional research in space processing methods, materials and experiment hardware.

One of the experiments in SPAR's flight was a metals casting experiment by Dr. Mary H. Johnston, a metallurgist at Marshall. The resulting 10.6-ounce (301-gram) sample is possibly the largest materials-casting experiment sample ever formed in space.

Dr. Johnston and Richard Parr, science advisor for the experiment will analyze the casting process and the resulting material to determine whether low-gravity processing can produce a more uniform distribution of elements than when processed on Earth.

Dr. Taylor Wang, a senior scientist at the Jet Propulsion Laboratory in Pasadena, Calif., was responsible for the other two experiments. Both of these used acoustic levitation in which sound waves suspend materials in mid-air while they are being processed. One of these experiments was to determine whether liquid drops can be manipulated in levitation and to study the resulting low-gravity mixing process. In the other experiment, air was injected into a droplet during the low-gravity time period to find out whether the air bubble would form a perfect sphere in the exact center of the droplet. This experiment, if successful, could lead to the manufacture in space of the glass microspheres necessary to nuclear fusion.

Roger Chassay, manager of the SPAR project at Marshall, reported that the Black Brandt rocket used in the flight performed well and that recovery was routine with no significant exterior damage to the payload. Two more SPAR launches are planned later this year.

A 10.6-ounce casting of a tin and lead alloy processed during the low gravity phase of the flight of the Marshall Space Flight Center's seventh SPAR (Space Processing Applications Rocket) flight May 14. This sample is possibly the largest ever formed in space.

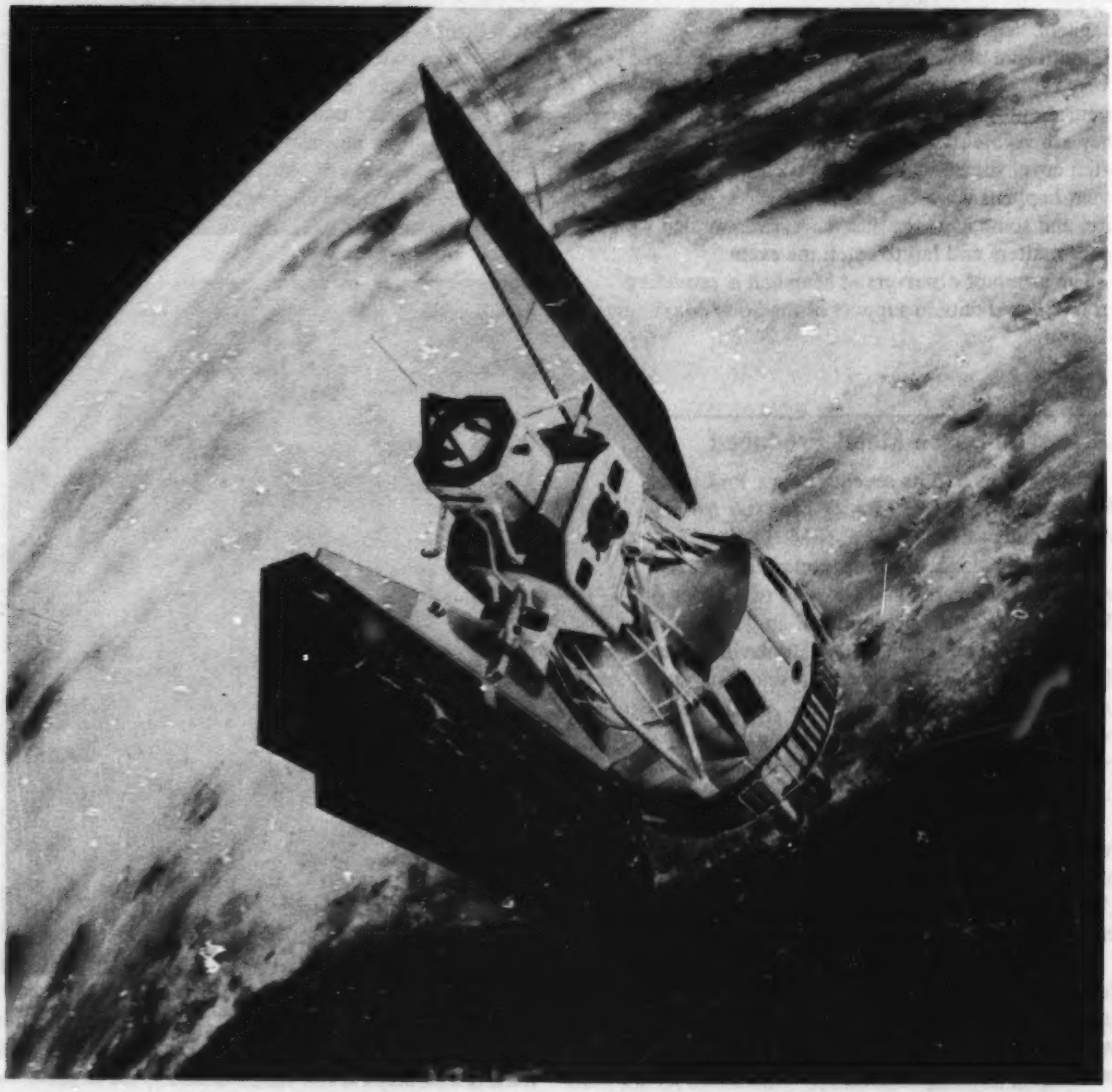
Landsat-2 Back in Service

After almost six-months retirement, NASA's five-year-old Landsat-2 spacecraft is back in service. The spacecraft, designed to study Earth resources from space, was "revived" following intensive efforts by engineers at NASA's Goddard Space Flight Center, Greenbelt, Md., to restore operations and through the development of a new "magnetics" technique which helps keep the polar-orbiting spacecraft stabilized.

The problems with the spacecraft developed on Nov. 5, 1979, when the satellite's yaw attitude flywheel, part of the mechanism that kept it pointed toward Earth, stopped functioning. The malfunction is thought to have been caused by a lubrication breakdown.

Without the flywheel functioning, the attitude-control system was unable to keep the spacecraft stabilized sufficiently to acquire pictures of the Earth. In addition, the spacecraft could not be maintained in an attitude that would permit its solar panels to collect the unnecessary energy from the Sun.

Because of those conditions, the spacecraft was "retired" on its fifth birthday, Jan. 22, 1980. At that time, Goddard engineers began an intensive effort to



Artist's concept of Landsat-2, the second earth resources satellite.

develop a technique to control the spacecraft using a magnetic compensation system that perhaps would restore control. In effect, they were faced with developing a new method of attitude control without the use of the flywheel and without the use of attitude control system gas, which had become depleted.

The engineers faced a number of problems in trying to develop control through magnetics. Among them was insufficient prelaunch knowledge of the spacecraft's magnetic characteristics which would be necessary for interaction with the Earth's magnetic field. In addition, the spacecraft has no direct yaw attitude measuring system, so that an indirect method had to be developed using the solar array output, which varied with the spacecraft's attitude and with its latitude position around the Earth.

Periodically during the development testing, attempts were made to reactivate the yaw flywheel. On May 5, 1980, apparently as a result of a redistribution of the lubricant, the flywheel responded to an "on" command and started running again.

With the yaw wheel operating, normal attitude control was able to keep the proper spacecraft attitude toward the Earth and the Sun. However, with the gas supply depleted, the magnetic system is required to keep the roll-and-yaw-axes flywheels in a safe range. The experience gained while attempting to control the spacecraft attitude with magnetics enabled this technique to be used to control the wheel speeds without developmental delays.

Goddard engineers believe development of the new operating procedures will allow Landsat-2 to operate near its previous capacity, although this will be limited to the direct readout mode since the Landsat-2 tape recorders are not functioning. The return to operational status is of significant importance in that the principal Earth imaging device, the Multispectral Scanner will once again provide Earth imaging data to three U.S. and nine foreign sites, thus supplementing Landsat-3 operations.

Space Antenna Study

NASA's Marshall Space Flight Center, Huntsville, Ala., has selected two firms for negotiations leading to parallel contracts for concept-definition studies of an experimental deployable space antenna. The 12-month studies, to be performed by the Grumman Aerospace Corp., Bethpage, N.Y., and the Harris Corp., Melbourne, Fla., will define the concept for a spaceflight experiment that would demonstrate, in low Earth orbit, the characteristics and performance capabilities of a large space antenna system.

Such a system, if put into wide use, could revolutionize communications, radar and radiometry operations from satelites. An evaluation of future requirements in these fields already has shown that large antenna systems in space will improve service in communications, Earth resources surveys, weather research, and other services now being provided by dozens of small satellites.

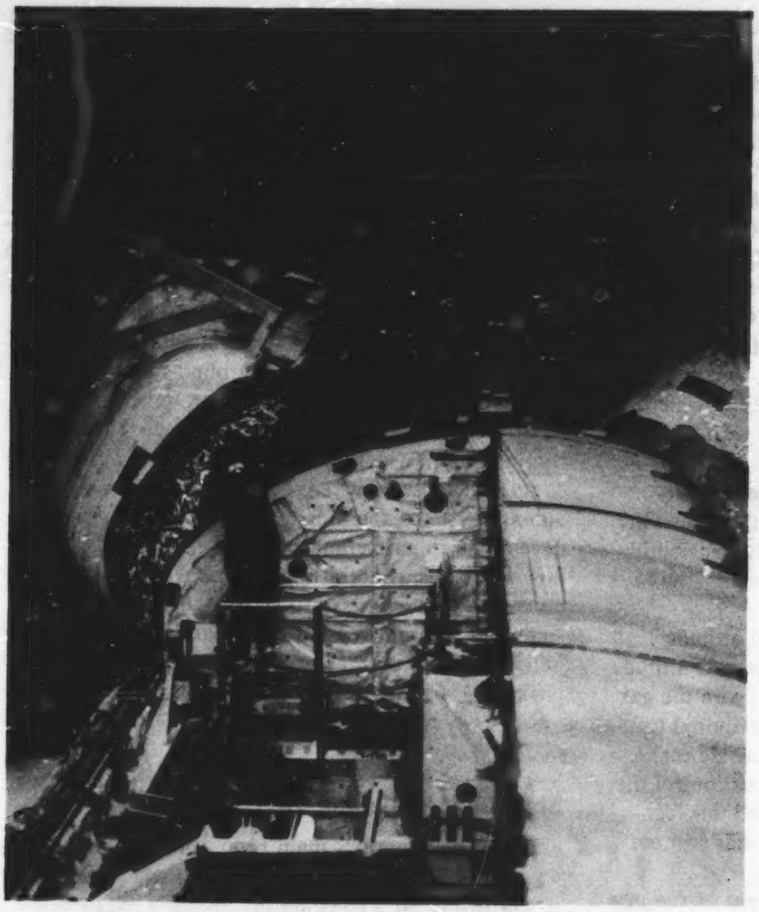
The growing number of communications satellites is rapidly depleting available transmission frequencies, requiring more and more large ground stations, and filling up available parking space in required orbits. Earth resources and weather research need better resolution and wider bandwidths.

As a step toward actual development of large space antenna systems, the Marshall Center proposes to develop an experimental space antenna that could be flown in low Earth orbit for test and demonstration purposes. This demonstration, to be defined in the studies by Grumman and Harris, would verify the antenna's structural integrity and test methods of packaging, transportation and orbital deployment.

Shuttle Propulsion Test Successful

The Space Shuttle's main propulsion system was successfully test fired for nine minutes and 38 seconds May 30, exceeding the duration required to place a Shuttle in orbit. The firing brings the total test time on the main Shuttle propulsion system, which consists of three engines, an External Tank and associated parts of the Orbiter, to 41.3 minutes—nearly three quarters of an hour of firing. This is in addition to the more than 20 hours of single engine tests that have been conducted in a separate program.

The main propulsion system test was conducted by the Rockwell International Space Systems Group, under the direction of NASA's Marshall Space Flight Center, Huntsville, Ala. Bob Bush, Marshall's resident manager of test operations at the National Space Technology Laboratories in Bay St. Louis, Miss., where the tests are conducted, said that the test met all its objectives. The Shuttle's engines were gimballed (steered) while firing, and they were throttled in stages from 100 percent of rated thrust down to 65 percent. The Shuttle will have the first man-rated engines capable of throttle control during flight.



Columbia's Right-Hand Maneuvering System—The right-hand maneuvering system on the Space Shuttle Orbiter *Columbia* is shown being installed at the Kennedy Space Center's Orbiter Processing Facility. Engines in both the left and right-hand pods provide the thrust to insert the Orbiter into final orbit after the main engine has cut off and the External tank has been jettisoned. The pods also maneuver the Orbiter in space for orbit changes, rendezvous with other spacecraft and return to Earth.

Shuttle Engines Flight Tests Completed

The last of the Space Shuttle Orbiter *Columbia's* three main engines successfully completed its second flight acceptance test June 16 with an eight minute and 40 second ground test run that exceeded the time required to put a Shuttle into orbit. All three engines now will be returned to the Kennedy Space Center, Fla., where they will be mounted on the vehicle before its maiden flight into space.

During the firing, engine number 2007 underwent throttling and gimballing exercises to test its ability to change speed and direction after liftoff. The other two flight engines, numbers 2005 and 2006, successfully completed their second flight acceptance test on June 2 and June 5, respectively, reaffirming the readiness of the three engines for flight.

The three engines had previously demonstrated their flight readiness in test firings last year. Since that time, several modifications and component replacements had been made and NASA felt it advisable to retest the engines. Successful retest of the three engines after the modifications and component replacements further verifies the design feature of the engines of replacing components on-line as will be required for its reuse capability.

Single Shuttle engines have accumulated more than 73,000 seconds (20 hours plus) of static test firing thus far, and engines clustered in main propulsion system testing have accumulated an additional 7,000 seconds (110 minutes).

One of the single engines being tested, number 2004, has completed two series of preliminary flight certification tests at 100 percent of rated power level, a series of three full-power tests at 109 percent, and will begin a series of tests at 102 percent later in June. This particular engine has accumulated almost 13,000 seconds of firing time, enough for more than 25 flights of the Space Shuttle.

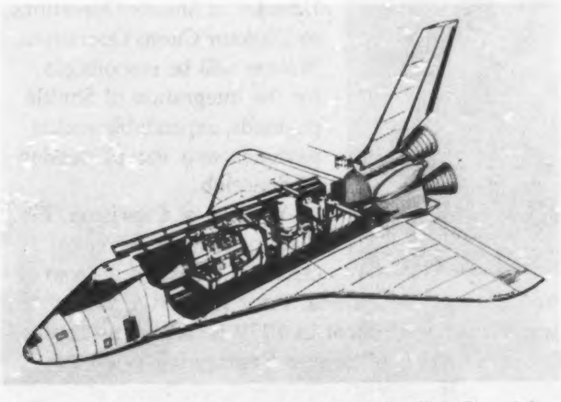
Second Spacelab Subsystem Ordered

NASA has ordered a second Spacelab Instrument Pointing System from the European Space Agency and its contractor, Dornier Systems of West Germany. This equipment, which is a major Spacelab subsystem, is valued at about $20 million.

The Instrument Pointing System is a three-gimbal device which will be mounted on a Spacelab pallet in the payload bay of the Space Shuttle Orbiter to provide highly accurate pointing capability for scientific instruments which require greater accuracy and stability than can be provided by the Shuttle itself. This system has the capability to lock onto and accurately track scientific targets such as stars, solar flares, or specific points of interest on the Earth's surface, unaffected by slight changes in Shuttle attitude.

The number of experiments currently planned demand such accurate pointing that a second unit had to be purchased. This second system supplements the first pointing system that NASA is to receive as part of the basic Spacelab equipment from the European Space Agency. Earlier this year NASA signed a contract with the European multi-national agency for the procurement of a second Spacelab flight unit. This new order will mean that both Spacelab flight units can be equipped with an Instrument Pointing System.

The Marshall Space Flight Center, Huntsville, Ala., is NASA's lead center for Spacelab development under the direction of the Office of Space Transportation Operations at NASA Headquarters. The first flight of Spacelab is set for May 1983.



Schematic diagram of Spacelab's payload facility. Spacelab, a joint venture of NASA and the European Space Research Organization (ESRO), is one of a number of different payloads that will be carried into space in the huge cargo bay of the Space Shuttle. The Spacelab will remain in the cargo bay for missions lasting from seven to 30 days.

Marshall Conducts Thunderstorm Observations

A NASA U-2 aircraft was used in a Marshall Space Flight Center experimental program in May which ranged from Rapid City, S.D., to Oklahoma and Texas. The Thunderstorm (lightning) Overflight Program was carried out by O. H. Vaughan of Marshall's Space Sciences Lab who made simultaneous ground measurements from the Severe Storms Lab of the National Oceanic and Atmospheric Administration at Norman, Okla. Vaughan said the pilot of the U-2, which was based at Ames Research Center, Mountain View, Calif., activated four experiments in the aircraft experiment bay as he flew at altitudes up to 65,000 feet (19,800 meters). Objective of the flights was to get optical, photographic, electrical and spectrographic data on lightning as the plane flew above severe weather formations.

Other investigators involved were Drs. Bernard Vonnegut and Richard Orville of State University of New York at Albany, Dr. Marx Brook of New Mexico Institute of Technology, and Dr. Dave Rust of the Severe Storms Lab. Dr. John Arvesen provided support and coordination from Ames.

Shuttle Special Support Structures

The Marshall Space Flight Center, Huntsville, Ala., is directing the development of special support structures to be used in the Space Shuttle Orbiter on an early flight in which experiments do not constitute a complete Shuttle payload. Two basically identical experiment equipment-support structures will be carried in the cargo bay holding three major experiment systems which are parts of a mixed cargo on the OSTA-2 mission scheduled for launch in 1982.

Each unit will be a basic truss structure made from 4x4-inch square aluminum hollow beams. The structures will be the same width as the cargo bay and will have triangular bases reaching to an attach point in the bottom of the cargo bay. Control weight is 1,200 pounds. The structures are to be designed, manufactured and assembled by Teledyne Brown Engineering Co. of Huntsville, Ala., under contract with Marshall.

The OSTA-2 flight will include elements of a cooperative mission between NASA and the Federal Republic of Germany. The experiments to be mounted on the structures include Marshall's MEA (Materials Experiment Assembly), Germany's MAUS (Materialwissenschaftliche Autonome Experimente Unter Schwerelosigkeit) and a solar array experiment.

KSC Promotes Four Top Managers

Four new appointments of top managers for the Kennedy Space Center have been announced by Center Director Richard G. Smith. *Raymond L. Clark,* Director of Design Engineering, was named Associate Director for Space Transportation System Development; *Peter A. Minderman,* Director of Technical Support, was appointed Director of Design Engineering; *Thomas E. Utsman,* was promoted to Director of Technical Support; and *Thomas S. Walton* was made Director of Cargo Operations.

As the Associate Director for STS Development, a newly created position, Clark will assist the Director and Deputy Director during the critical period leading to the initial Space Shuttle launch. Smith says, "Clark's principal responsibilities will be to maintain technical cognizance of areas of highest priority and particular sensitivity to the Space Transportation System at KSC and our cargo operations."

Clark began his career at KSC while completing 20 years of active duty with the Army assigned to the Army Ballistic Missile Agency. Following his retirement from the Army in 1966 he was named Director of Technical Support at KSC. In 1972 he was promoted to Director of Design Engineering.

A graduate of West Point and a native Oklahoman, Clark holds a masters degree in aeronautics and guided missiles from the University of Southern California.

Minderman has served as Director of Technical Support since 1972. He joined NASA in 1960 after working in private industry and as a member of the Army's rocket development team. Minderman began his career at KSC as an aeronautical instrumentation research engineer. Later he served as Chief of Telemetric Systems and Deputy Director of Information Systems. In the latter job he played a major role in research and development of ground instrumentation systems related to the Apollo/Saturn V configuration.

A native of Port Clinton, Ohio, Minderman graduated from Ohio State University with a degree in chemical engineering.

In his new position as Director of Design Engineering, Minderman will be responsible for the design and acquisition of ground-support equipment, systems and facilities for launch operations and support elements at KSC.

Utsman, as Director of Technical Support, will be responsible for support services in connection with the KSC checkout and launch operations. A native of Detroit, Mich., he graduated from the University of Michigan in 1958, receiving a bachelor of science degree in mechanical engineering. Utsman continued his education after joining KSC in 1963, earning a master of science degree in management from Florida State University in 1968.

After rising to Associate Director of Design Engineering, Utsman was appointed Director of Operations Management in February 1979. In that position he had been responsible for integrating operational support efforts within the Technical Support Directorate.

Moving up from Deputy Director of Shuttle Operations, to Director Cargo Operations, Walton will be responsible for the integration of Shuttle payloads, expendable rocket payloads and the processing of Spacelab.

A native of Clewiston, Fla., Walton earned a degree in electrical engineering from the University of Florida. Prior to moving to his most recent assignment in 1979 he served as Deputy Director of Shuttle Engineering where his primary responsibility was the development of Shuttle computer programs for the Launch Processing System.

In 1977, Walton was presented the first annual Director's Award, the single highest local honor that can be given a KSC employee.

NASA Selects 19 Astronaut Candidates

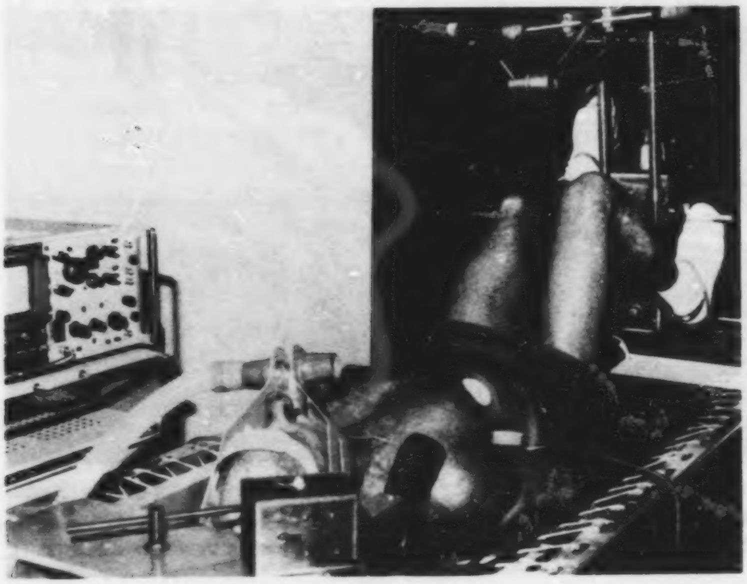
NASA has announced the selection of 19 new astronaut candidates for the Space Shuttle Program. The candidates began a one-year training and evaluation program July 7 at the Johnson Space Center in Houston. After the program at Johnson, successful candidates become astronauts and enter the Shuttle training program leading to selection for Shuttle flight crews.

Pilots will operate the Space Shuttle Orbiter, maneuvering it in Earth orbit and flying it to Earth for a runway landing. Mission specialist astronauts will have the overall responsibility for the coordination, with the commander and pilot, of Space Shuttle operations in the areas of crew activity planning, consumables usage, and other Space Shuttle activities affecting experiment operations. They may participate in extravehicular activities (space walks), perform special payload handling or maintenance operations using the Space Shuttle remote manipulator system, and assist in specific experiment operation at the discretion of the experiment sponsor.

NASA received 2,880 applications for mission specialist positions and 585 for pilot positions. Of these, 21 finalists were interviewed and given detailed evaluations at the Johnson Center.

Of the 19 selected, eight are pilot candidates and 11 are mission specialist candidates. Two of the mission specialist candidates are women. One pilot candidate is black and one mission specialist is Hispanic. The new group of candidates includes William F. Fisher, the husband of Anna Fisher, who was selected for the astronaut candidate program in 1978. Six civilians, including three current employees of the Johnson Space Center, and 13 military candidates, one of whom is assigned to Johnson, were selected.

Names of the 19 candidates, their military status, and their type of candidacy are: James P. Bagian, civilian, mission specialist; Lt. Col. John E. Blaha, U.S. Air Force, pilot; Maj. Charles F. Bolden, Jr., U.S. Marine Corps, pilot; Lt. Col. Roy D. Bridges, Jr., U.S. Air Force, pilot; Franklin R. Chang, civilian, mission specialist; Mary L. Cleave, civilian, mission specialist; Bonnie J. Dunbar, civilian, mission specialist; William F. Fisher, civilian, mission specialist; Maj. Guy S. Gardner, U.S. Air Force, specialist; Maj. Guy S. Gardner, U.S. Air Force, Capt. David C. Hilmers, U.S. Marine Corps, mission specialist; Lt. David C. Leestma, U.S. Navy, mission specialist; John M. Lounge, civilian, mission specialist; Maj. Bryan D. O'Connor, U.S. Marine Corps, pilot; Lt. Cmdr. Richard N. Richards, U.S. Navy, pilot; Capt. Jerry L. Ross, U.S. Air Force, mission specialist; Lt. Cmdr. Michael J. Smith, U.S. Navy, pilot; Maj. Sherwood C. Spring, U.S. Army, mission specialist; and Maj. Robert C. Springer, U.S. Marine Corps, mission specialist.



Effects of Weightlessness—NASA's Ames Research Center, Mountain View, Calif., conducted a three-week study in April-May 1980 to determine the effect of weightlessness upon the body. For this study, prolonged bedrest is used to simulate weightlessness. Subjects perform a bicycle exercise as shown in photo before the experiment to help scientists determine the condition of their cardiovascular systems prior to the test. At the conclusion of the experiment, the subject must again bicycle before rising to show whether the heart has deconditioned while lying in bed. Shown bicycling is subject Frank Holland. At 57, he is one of the oldest human volunteers ever tested in this experiment.

Shuttle Recovery Contract Awarded

United Space Boosters, Inc., has been awarded a contract to establish and operate a two-ship recovery force to retrieve expended Space Shuttle solid rocket boosters from the Atlantic Ocean. The firm is a subsidiary of United Technologies Corp., Chemical Systems Div., Sunnyvale, Calif., and is located in Huntsville, Ala. The contract will be managed by the John F. Kennedy Space Center, Fla.

The $7,231,000 agreement formalizes a letter contract issued July 13, 1979, and covers the period through Feb. 28, 1982. Options for the two specially constructed recovery vessels to be operated by the company under the contract extend for a 14-year period through Feb. 28, 1995. The agreement supplements a contract under which the firm

The launching of the UTC Liberty, one of two recovery ships to be used by NASA to recover the expended Space Shuttle solid rocket boosters from the Atlantic Ocean. The new vessels were designed for United Technologies Corp., United Space Boosters, Inc., by Rudolph T. Matzer and Associates, Jacksonville, Fla., and are under construction by Atlantic Marine, Inc., Fort George Island, Fla.

assembles and processes solid rocket boosters for flight, bringing the total current value of the parent contract to $17,718,000.

Under the recovery contract, United Space Boosters, Inc., is to deploy a force to locate and retrieve expended solid rocket booster casings, parachutes and other flight elements from the Atlantic Ocean and deliver them to the Solid Rocket Booster Disassembly Facility located at Cape Canaveral Air Force Station.

The new vessels, of molded steel hull construction, have been designated the UTC Liberty and UTC Freedom. They were designed for United Technologies Corp., United Space Boosters, Inc., by Rudolph F. Matzer and Associates, Jacksonville, Fla., and are under construction by Atlantic Marine, Inc., Fort George Island, Fla. The vessels are to be delivered to KSC in October 1980 and January 1981. Both ships will be used on each Shuttle mission; each can retrieve one booster and associated components.

The retrieval ships will carry the necessary equipment to plug booster nozzle cavities, pump out water in the casings, and bring them into horizontal position for towing back to the Disassembly Facility. Four parachute rollers on each vessel will be used to retrieve the three main and single drogue parachutes on each booster and each ship will be equipped with cranes to hoist collateral flight equipment aboard. The vessels will feature sophisticated electronic communications and navigation equipment that includes a satellite navigation system, search radars, collision-avoidance sonars with transponders, radars, Loran C, VHF and single-sideband high-frequency radio systems, direction finders, fathometers and gyro compasses.

The vessels will be 53.6 meters (176 feet) long, have a beam of 11.3 m (37 ft), a depth of 4.6 m (15 ft), draw 2.7 m (9 ft) of water, and have a displacement of 955 metric tons (1,052 tons).

At sea, propulsion will be provided by twin diesel engines with a combined power output of 2,900 horsepower. Maneuvering ability will be provided by a diesel-driven 425-hp bow thruster. Propulsion in the Banana River, location of the Booster Disassembly Facility, will be provided by a 425-hp waterjet stern thruster in an effort to protect the manatee (or sea cow), an endangered species which make these waters their home. Use of the stern thruster will eliminate danger to the manatees from propellers which can maim or kill the animals. The vessels will have a sustained speed capability of 24 kilometers per hour (13 knots), a range of 11,000 km (6,900 statute miles) and a complement of 24—12 crew and 12 retrieval specialists.

During a launch, two solid-rocket boosters, 45.4 m (149 ft) tall, will burn simultaneously with the Space Shuttle Orbiter's three main engines at liftoff. They will burn for about two minutes before they are jettisoned at an altitude of approximately 45 km (28 mi). The expended booster casings will impact in the Atlantic Ocean approximately 257 km (160 mi) downrange from KSC's Launch Complex 39, each one's final descent into the water slowed by three parachutes, 35 m (115 ft) in diameter.

After return to the Disassembly Facility, the casings will be cleaned and disassembled for shipment to Utah for reloading with solid-rocket propellant. Each casing can be reused for up to 20 missions, substantially reducing the cost of flight operations in the Space Shuttle era.

Marshall to Manage New Solar Energy Systems

The Marshall Space Flight Center has been assigned responsibility for providing technical management for 843 new solar energy systems to be installed in federal buildings across the nation. The Department of Energy announced the selection of the new projects May 29. This brings the total number of solar heating and cooling sites managed by Marshall to more than 1,000.

Almost $32 million in DOE funds have been allocated to Marshall for completion of the 843 new projects. The program includes funding for 734 hot water systems; 16 heating systems; 7 cooling systems; 51 heating, cooling, and hot water systems; 11 industrial process heat systems; and 24 hybrid and passive systems.

The Marshall Center will assign a site manager for each project whose duties will include approving final designs, providing technical assistance, and validating operation and maintenance data. Most of the projects will be completed and in operation within 12 to 32 months after the allocation of funds.

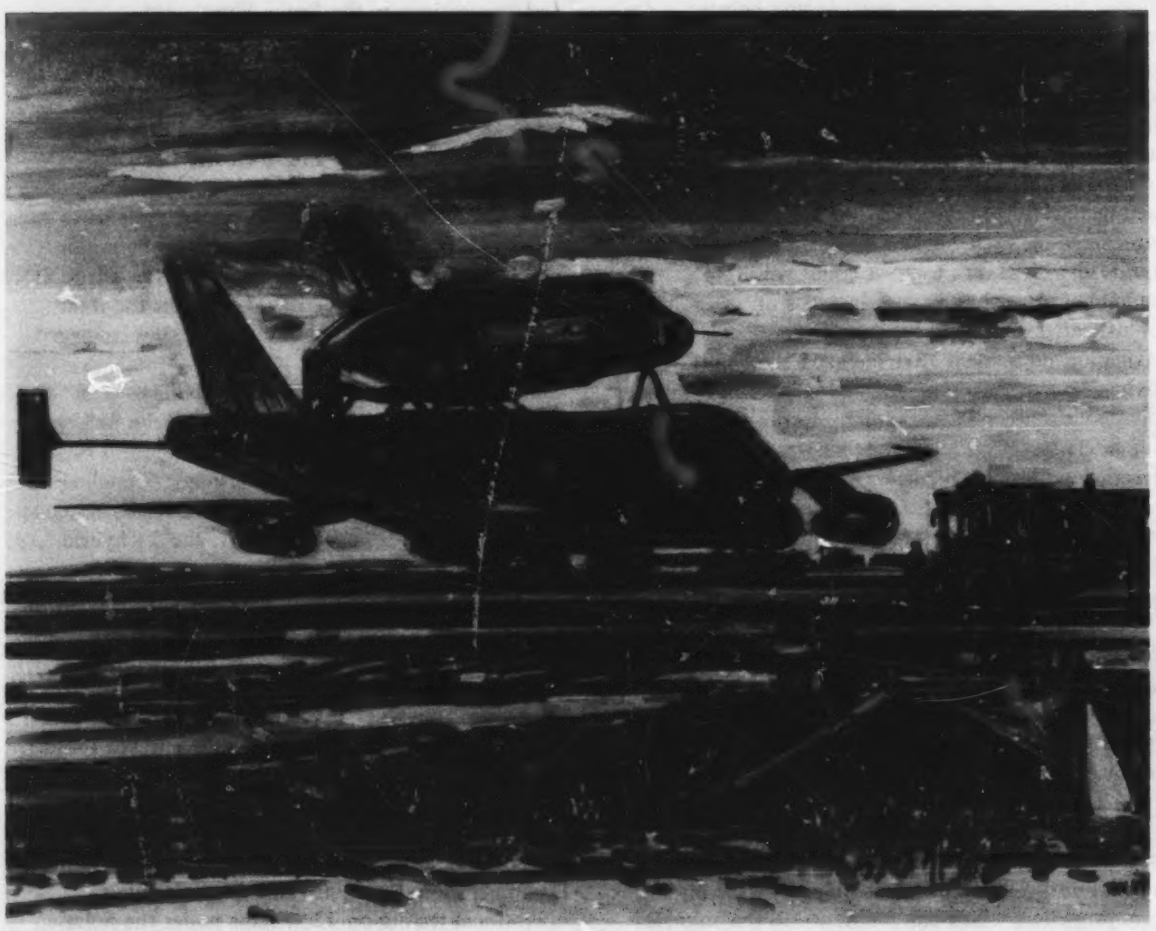
In addition to the Solar Federal Buildings Program, Marshall has provided technical management support to DOE for 1[illegible]7 solar energy systems under the Solar Heating and Cooling Commercial Demonstration Program, and is performing operational testing on 42 systems under the Solar Heating and Cooling Development Program.

NASA's Fine Art Program

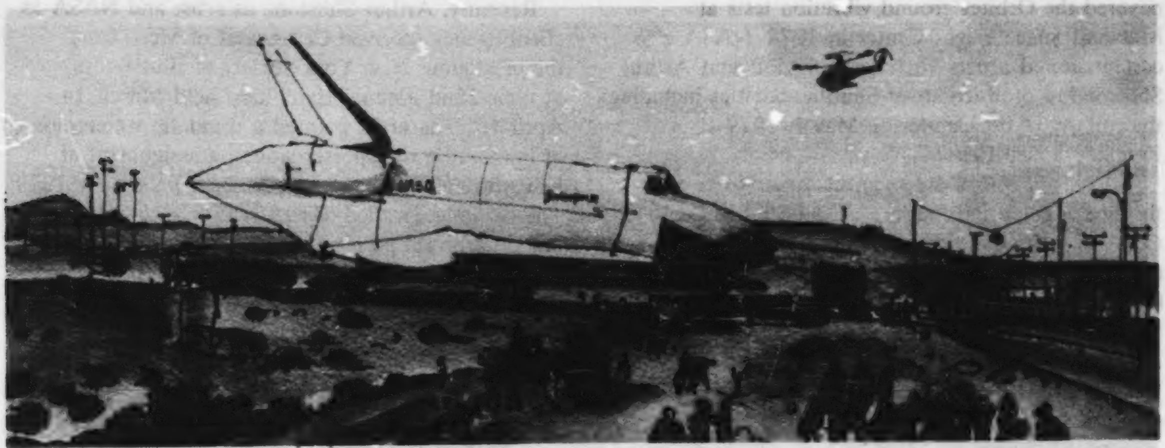
For the past 17 years, NASA has conducted an active art program for the purpose of collecting an archival history of man's exploration of space. Under a mandate to keep the public informed about its progress in space exploration, NASA's art program seeks to provide new insights into various space-program activities. Thus, nationally known artists have been invited to pictorially document major NASA activities. Bob Schulman, NASA Graphics Coordinator, Public Affairs Division at Headquarters, is responsible for the selection and commissioning of artists and management of the program.

Artists participating in this program have ranged from traditionalists, such as Peter Hurd and James Wyeth, to modernists such as Robert Rauschenberg and Lamar Dodd. The art produced varies in style from subjects closely seen and sharply delineated to those only sensed or imagined by the artist. NASA has made it possible for artists to be stationed at the closest observation points to Apollo Saturn moon launchings. They have been aboard recovery ships when astronauts have returned from their long voyages. Artists have piloted Lunar Module simulators to make-believe moons. In short, NASA has tried to provide them with every possible space view and experience.

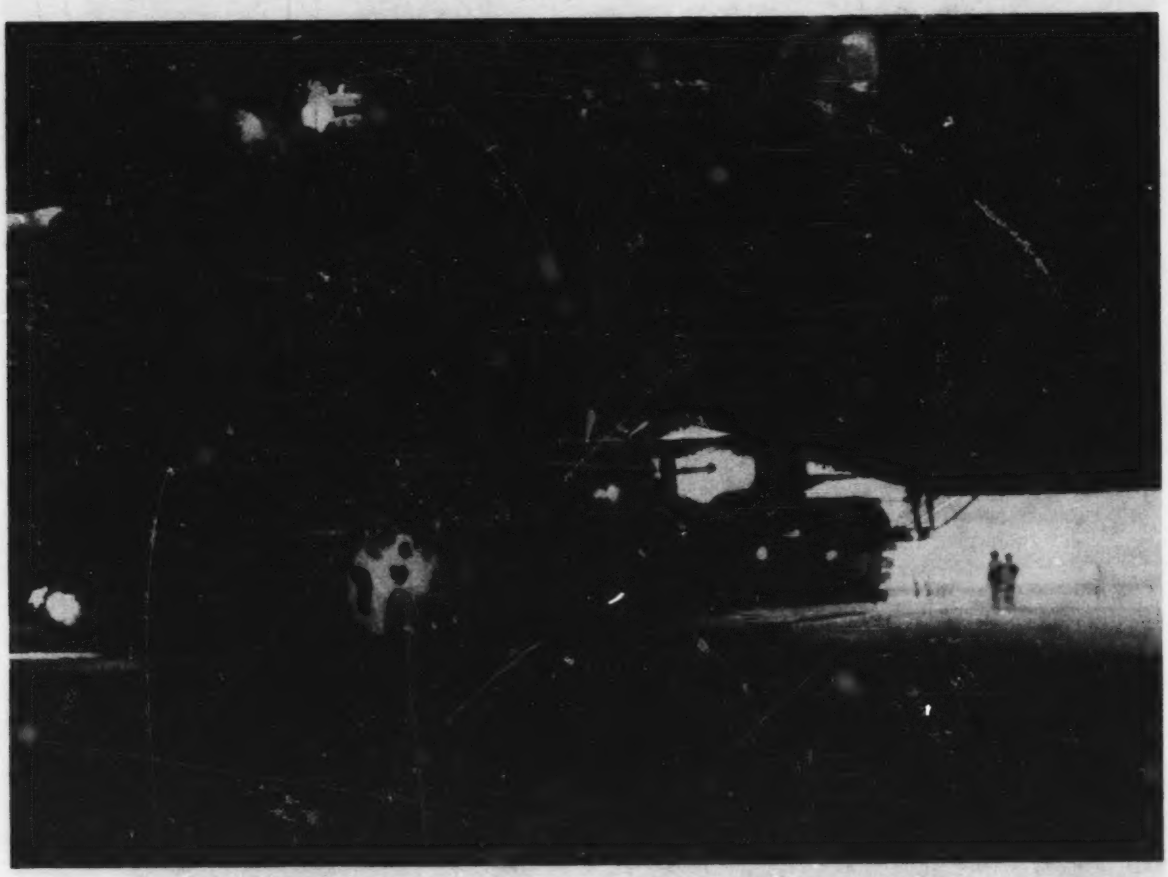
In 1977, NASA commissioned Robert T. McCall to document, in drawings and paintings, activities related to the roll out of the Space Shuttle *Enterprise* at Dryden Flight Research Center. During 1978, artists Franklin McMahon and Tom O'Hara were commissioned to produce works of art documenting the first free-flight of the Shuttle Orbiter. Artists Arthur Shilstone and Clayton Pond



Artist Tom O'Hara's painting entitled "Taxi Orbiter and 747."



Artist Robert McCall's painting depicting the Space Shuttle Orbiter's move from the Rockwell International Assembly Facility at Palmdale, Calif., to the Dryden Flight Research Center at Edwards, Calif.

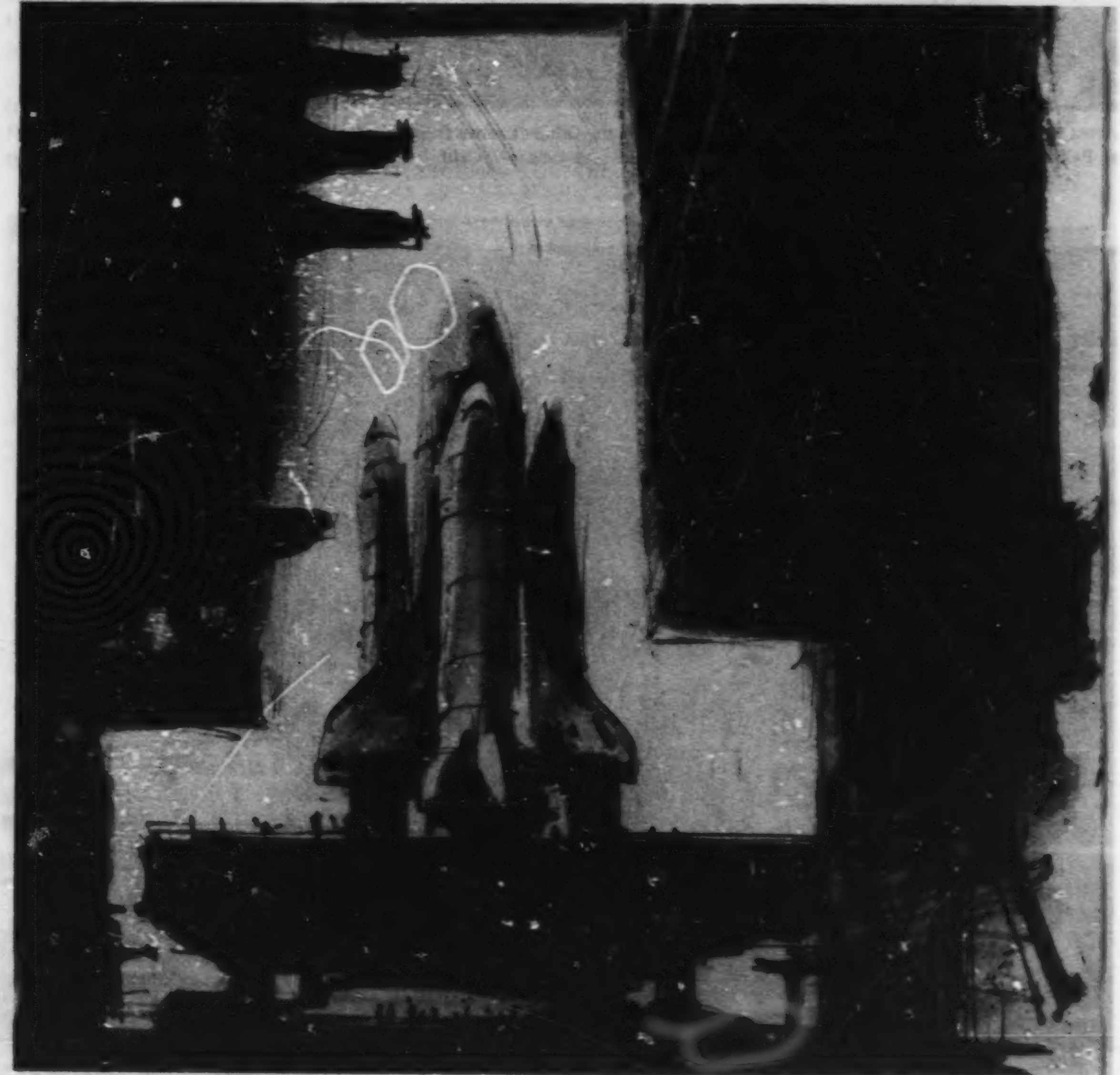


Artist Arthur Shilstone's prize-winning watercolor entitled "The Crawler—Roll Out of the Enterprise," at the Kennedy Space Center on May 1, 1979. Shilstone recently received a Certificate of Merit from the New York Society of Illustrators for this work.

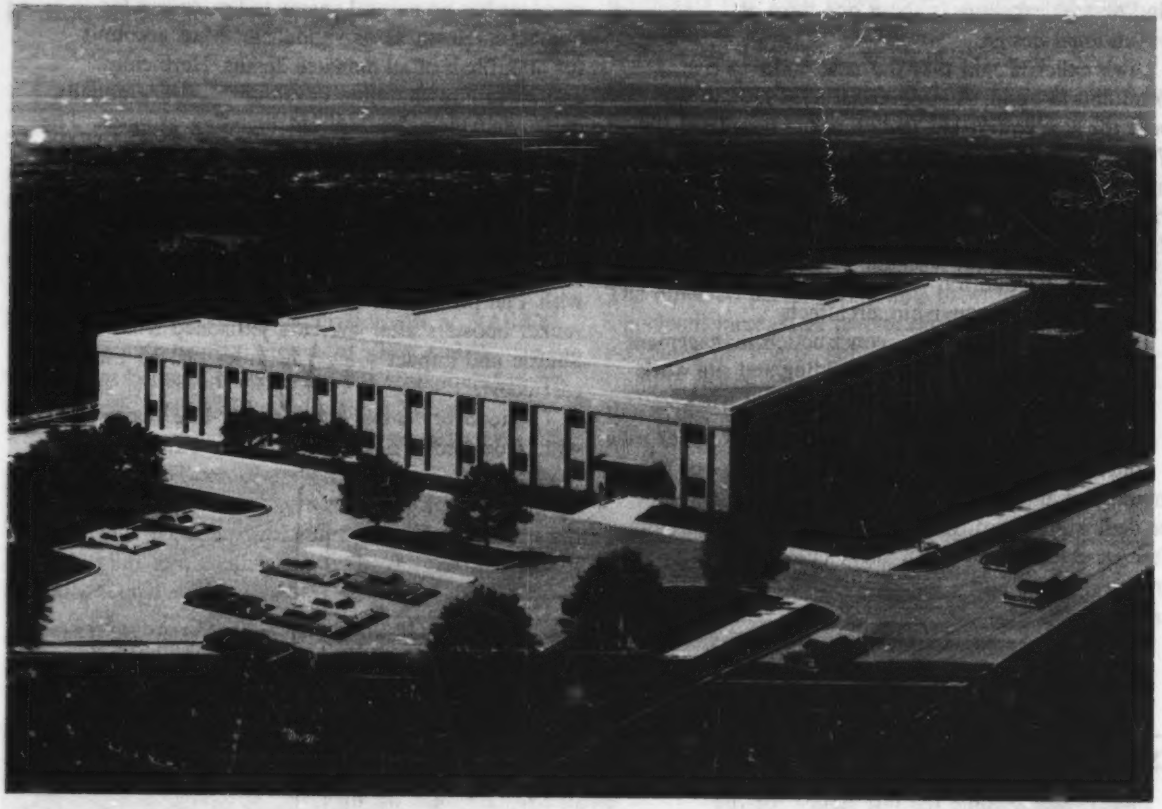
covered the Orbiter ground vibration tests at Marshall Space Flight Center in 1978. NASA also commissioned artists Nicholas Solovioff and Arthur Shilstone to produce art of Shuttle activities including the roll out of the Orbiter on May 1, 1979 at Kennedy Space Center.

NASA plans to use a team of artists to cover the first launch and landing of the Shuttle Orbiter *Columbia*. In addition, artists also will go on assignment to cover aeronautics activities and other subjects of interest throughout the agency.

Recently, Arthur Shilstone as artist and NASA as client agency received Certificates of Merit from the prestigious New York Society of Illustrators at their 22nd Annual Exhibition held March 14–April 10. The artist painted a dramatic watercolor of the Shuttle transporter while on assignment at KSC during the roll out of the *Enterprise* May 1979. The painting, entitled "The Crawler—Roll Out of the Enterprise," will appear in the Society's 1980 art annual and has been on an international exhibition tour which included Japan and China.



Artist Nicholas Solovioff's watercolor of the Space Shuttle *Enterprise* leaving the Vehicle Assembly Building at Kennedy Space Center on May 1, 1979.



Lewis Computer Facility Dedicated

The nation's leading computer center for aeronautical propulsion research was dedicated May 29 at NASA's Lewis Research Center, Cleveland, Ohio. The new facility, called the Research Analysis Center, will greatly enhance Lewis' capability to design new and improved versions of aircraft engines and favorably impact other areas of the Center's energy-conversion activities.

"The RAC enables NASA to 'build' computer models of jet engines and other energy-conversion systems before having to commit extensive time and money to building and testing actual hardware," commented Lewis Director Dr. John F. McCarthy, Jr. "Moreover the facility eventually will serve NASA needs across the nation as well as interests of the scientific community at large. This will be possible through expansion, which is provided for in the building design and sophisticated linkages, some through satellite, with companion computers in various parts of the country," he said.

The two-story, 66,000 square-foot building features the fastest computer built by the IBM Company, the 370/3033 unit, which will help produce a tenfold increase in the speed of the Lewis Center's computational capabilities. The RAC is the first major research addition at Lewis since 1967 and boasts the most energy-conservative design of any building in the NASA organization nationwide featuring a waste-heat recovery system, high-pressure sodium lighting, extensive building insulation, and reduced window-area exposure. Waste heat from the computer operations will be used to heat the computing room, offices, and service areas. The recovered heat will be "stored" in a 70,000-gallon water tank buried just below the mechanical equipment portion of the building. RAC's sodium lighting is expected to reduce consumption of electricity for lighting by 60 percent over conventional construction. The building walls are constructed with insulated hollow cores of concrete blocks and, in addition, three inches of insulation have been applied to the inside surface of exterior walls. The roof is inversely insulated with a three-inch thick layer of stiff, closed-cell material installed above the roofing surface rather than below it as in conventional structures. RAC's window-area exposure is about one-third of conventional design.

Lewis officials said that the new building cost $6 million to build. An additional $7.4 million was spent for new equipment including the new IBM 370/3033 computer. Construction was completed on schedule and within budget. Six Cleveland firms were principals in the design and construction of the Research Analysis Center:

- Madison & Madison International, architects
- Hoag Wismar Partnership, architects
- Turner Construction Co., construction management
- Roediger Construction Inc., building and site work
- Reliance Mechanical Corp., mechanical work
- Hatfield Electric Co., electrical work.

Some 150 leaders from local government, business, universities and civic organizations took part in the dedication, touring the new computer operations after Dr. McCarthy ceremonially cut ribbon-like streamers of computer tape to officially open the RAC for business.

KSC Sanctuary for Endangered Species

Florida has become the last refuge for the manatee (sea cow), an endangered species with numbers decreasing at an alarming rate. Brevard County, in which the Kennedy Space Center is mainly located, has the highest incidence of manatee deaths in the state. This alarming statistic has caused NASA to focus its attention on this native Floridian and to take steps to ensure its survival in the brackish rivers and lagoons surrounding the nation's Spaceport.

The manatee is a large, ponderous aquatic mammal, shaped much like a fat cigar with two small, front flippers and a broad, spatula-shaped tail. Strictly vegetarian, these gentle creatures can consume up to 100 pounds of food per day, may grow to over 12 feet in length, and can weigh over 1,000 pounds.

Because it is a mammal, the manatee must surface every few minutes to breathe. The slow-moving animal usually raises its snout just above water, making it an extremely vulnerable and well-hidden target for fast-moving motorboats. Most adult manatees bear the scars of a close encounter with their destructive neighbors. Boating accidents caused one-third of all manatee deaths last year. The manatee has no natural enemy today, except for human carelessness or vandalism. Man accounts for about half of all manatee deaths. Herbicides and spreading shoreline development are gradually destroying their feeding and breeding grounds. The greatest culprit, however, is the powerboat's lethal propellor blade.

Even the Space Shuttle program has made some allowances for manatees—changes which will benefit both parties. NASA will be using ships outfitted with a jet propulsion unit to recover the spent rocket boosters after they are jettisoned from the Shuttle and impact some 150 miles off the Florida east coast.

The recovery ships, large trawler-like vessels, will be docked in one of the manatee's favorite feeding grounds in the Banana River. The jet propulsion unit will enable the crew to maneuver the ship in any direction at a low speed without the use of the ship's large propellers. Not only will these propulsion units be safer for the manatees, but they will be useful in retrieving the boosters at sea. By switching to jet propulsion, the possibility of parachute lines becoming entangled in spinning propellers will be eliminated during the recovery procedure.

NASA has undertaken several projects to study and thereby help the manatee. Space technology was used to develop tracking devices which permitted wildlife workers to monitor the routes travelled by individual animals. NASA funded aerial surveys in and around KSC to learn more about populations and group migratory habits. These studies have provided valuable insight concerning warm and cold weather feeding grounds, permitting KSC engineers to schedule work in specific areas when the manatees will be absent.

In addition, anyone who operates a boat under U.S. Government control in KSC waters must take a manatee-training class, taught by the U.S. Fish and Wildlife Service. This course has also been taught to area Coast Guard members, who will hold classes for the general public.

At one point, manatees flourished throughout the coastal states of the southeastern United States, but were hunted extensively for their meat, blubber and ivory-like bones. Their numbers dwindled to the point where the entire U.S. population, estimated at about 1,000, now lives in Florida waters. Manatees have been protected by state law since 1893 and the Marine Mammal Act of 1972 bans hunting them in U.S. waters.

Motion Sickness Prevention

Prevention of motion sickness might be learned much as a person learns to balance and ride a bicycle, says a NASA scientist who has studied responses to motion sickness in more than 100 subjects. If your brain has something akin to the sound of a wrong note to tell it when your body is "off-key," you can learn to control physiological responses to motion, such as nausea, according to Dr. Patricia Cowings, psychophysiologist at NASA's Ames Research Center, Mountain View, Calif.

Cowings believes she may have a technique for dealing with motion sickness induced by the weightless environment of space. About half of all astronauts who have flown in space have had some symptoms of motion sickness.

Working at the Ames biomedical laboratories, Cowings and her associate, William Toscano, have taught about 50 volunteers to suppress illness when subjected to an ever-faster spinning chair. Another 60 subjects were studied without the training. Eighty-five percent of the trained subjects improved their ability to withstand motion. Sixty-five percent were able to completely suppress illness symptoms. The other 20 percent were able to withstand a significant increase in revolutions per minute before becoming ill. The 60 subjects who received no training represented the control group. No one in that group showed any significant improvement with time.

Ames laboratory assistant Leah Schafer, of Kalamazoo College, Kalamazoo, Mich., is strapped into a vertical acceleration device by Dr. Patricia Cowings. The vertical motion simulator is one of the devices used by Cowings to induce motion sickness in human volunteers.

The trained subjects monitored their own bodily functions such as respiration and heart rate during the course of the experiments. This biological feedback system has been used by other researchers and often produces significant positive results.

Biofeedback was used with the trained subjects in the spinning chair. Once they were trained to detect the biological signs of the onset of motion sickness, 65 percent of the trained subjects were able to suppress the illness symptoms.

Advantages of biofeedback over conventional treatments for motion sickness (drugs are usually administered) include an absence of side effects such as the sleepiness common with some drug therapy.

Cowings would like to test her theories in space and has proposed an experiment which has tentatively been selected along with other life-science experiments for the first two life-science Spacelab flights. Cowings' space experiment would involve trained crewpersons who would wear a biomedical harness feeding eight separate channels of a small portable data recorder. The recorder would collect information about the subjects' heart rate, skin resistance and other factors. If the subject could not suppress the onset of motion sickness symptoms, they would mark the recorder at the point where they became sick. This would enable Cowings and other researchers to study the tapes later and perhaps determine how the subject became sick or what physiological responses led to the sickness.

CATE Truck Visits Lewis

Besides the markings on its tractor and trailer panels, the muted and intriguing whirr of its powerplant tells the onlooker that this handsome black-and-white experimental turbine-powered truck is the only one in the country today demonstrating ceramic components.

Several dozen employees took turns riding in the truck's cab on its recent visit to the Lewis Research Center in Cleveland. Developed under the CATE (Ceramic Applications in Turbine Engines) Project,

TURBINE POWERED

The only turbine powered truck in the nation today demonstrating use of ceramic engine components recently visited the Lewis Research Center. The gas-turbine truck was developed under the CATE (Ceramic Applications in Turbine Engines) Project, managed by Lewis for the U. S. Department of Energy.

managed by Lewis for the U.S. Department of Energy, the truck's gas-turbine engine has 13 structural ceramic components, including regenerators, stator vanes and a turbine-tip shroud. The project contractor is the Detroit Diesel Allison Division of General Motors.

Ceramic components allow the gas turbine to operate at a higher temperature than do conventional metal parts, thus improving engine-cycle efficiency and fuel consumption, according to project manager Thomas J. Miller at Lewis. The basic engine is a Detroit Diesel Allison GT-404 all-metal gas turbine to which the ceramic components have been added to increase turbine inlet temperature from the standard engine's 1002° C (1836° F) to 1038° C (1900° F), with multifuel capability. In two future versions, the engine will be fitted with increasing numbers of ceramic components so as to operate at turbine inlet temperatures of 1132° C (2070° F) and 1241° C (2266° F).

When the project is completed in 1984, project engineers will compare fuel-consumption data for each of three ceramic configurations at progressively higher temperatures. Ultimately the 1241° C (2266° F) configuration is expected to reduce fuel consumption 20 percent compared with that of the conventional all-metal gas turbine.

The 1038° C (1900° F) version that visited Lewis is rated at approximately 300 horsepower, virtually the same as that of the standard GT-404. Road tests have been conducted with a trailer payload of 65,000 pounds, simulating commercial service. The engine is backed up by a four-speed automatic transmission, to provide a good balance of driveshaft torque for starts, acceleration, and hill-climbing as well as protection against engine-turbine overspeeding.

From Cleveland, the turbine-powered truck traveled on for stops and demonstrations in Pennsylvania and New York State, including the Corning Glass Work, in Corning, N.Y., where the regenerator materials used in the engine's ceramic components were made.

NASA's MATE Van

For over three years, NASA's Regional Remote Sensing Applications Program has been helping states and local governments use Landsat satellite data for natural resource and environmental management applications such as forest and agriculture inventories, urban and land cover analyses, water resources and coastal zone studies. To date, some 29 states have been directly involved in the program. Although the three responsible NASA Centers (Ames, Goddard, NSTL) have extensive in-house capabilities to support the program, the number of state personnel who can get the travel funds and release time to work at the centers has been limited.

Broader understanding of the ways in which Landsat data can be used must be achieved before the technology can be accepted as an operational tool and the support of policy-making officials both in state agencies and in the legislatures is particularly important. The Ames Research Center's MATE facility (Mobile Analysis & Training Extension) is a 30-foot mobile van with a stand-alone Landsat data analysis capability and a "have tapes will travel" commission to increase awareness of Landsat technology in the 14 western states for which Ames has the technology transfer responsibility. The heart of the system is a Hewlett-Packard HP 3000 Series 33 computer and the Interactive Digital Image Manipulation System (IDIMS) analysis software produced by Electromagnetic Systems Laboratories, Inc. A full color interactive video display manufactured by De Anza, Inc., is the principal user interface of the system for reviewing the raw and processed Landsat imagery and overlaying it with the topography, geopolitical boundary, soils and other data frequently needed to address resource-management applications.

Inaugurated at a 14-state Landsat applications symposium in October 1979, the MATE van will be used in three ways; (1) to familiarize state governors, legislators and agency managers with satellite data; (2) to train agency personnel in image-analysis techniques needed to interpret Landsat data and relate it to other data sources; (3) to conduct short term demonstration projects on-site with state and local resource agencies.

On its first tour, the MATE van visited Sacramento, Calif., where legislators and state agency representatives participated in workshops and demonstrations. The MATE van then toured the Pacific Northwest where the use of Landsat data is rapidly becoming a useable tool for resource agencies in the three states. All three states are now building a capability to use Landsat data operationally. Governor Ray of Washington, Governor Evans of Idaho and Governor Atiyeh of Oregon, each visited the MATE van in their respective states to review the results of demonstration projects. An estimated

Traveling for the Ames Research Center, the Mobile Analysis and Training Extension (MATE) van spent two weeks this spring in the parking lot of the Colorado capitol, where Ames project representatives demonstrated how satellite technology can be applied to the state's environmental problems.

750 other individuals also visited the van in the three states including many key state legislators, agency heads and their staff. For many, it was a first exposure to the space technology to which their states are becoming committed.

MATE's second tour, completed in June, covered the states of Montana, Utah, Colorado and Nevada. Among the 650 state officials visiting the van and viewing Landsat demonstrations were Utah's Governor Scott Matheson and Nevada's Governor Robert List. Visits to the remaining states in the 14-state region served by Ames are scheduled to be completed by the end of 1980.

With resource and environmental management a priority need of state and local governments, the MATE van promises to be an increasingly effective tool to bring the vanguard of space technology to a wide cross section of diverse users.

Lewis Turbo Truck Fuel Efficient

An experimental turbocompound 450-horsepower diesel engine recently has demonstrated a four-percent improvement in fuel economy in a fully loaded tractor-trailer on nine consecutive round trips between Florida and Calfiornia for a total distance of approximately 50,000 miles, according to the NASA Lewis Research Center, Cleveland. Specially designed for heavy-duty trucks, the engine can potentially deliver a fuel-economy gain of as much as five percent under the most demanding conditions of maximum legal load and mountainous terrain.

The demonstration is the first known highway application of the successful aircraft-engine technology of turbocompounding. The project, funded by the U.S. Department of Energy (DOE), was managed by Lewis. Cummins Engine Company, of Columbus, Ind., developed the turbocompound technology for highway use and supplied the engine.

The power plant's turbocompounding feature utilizes waste energy in a turbine driven by the diesel engine's own exhaust gases; the recovered energy is returned mechanically to the engine drive train. Mechanical coupling of the recovered energy distinguishes turbocompounding from the more common concept of free-floating turbocharging. In the demonstration engine turbocompounding and turbocharging were combined to maximize fuel economy. The turbocharger exhaust is ducted to a low-pressure turbine coupled to the engine's crankshaft by a speed-reduction gear train.

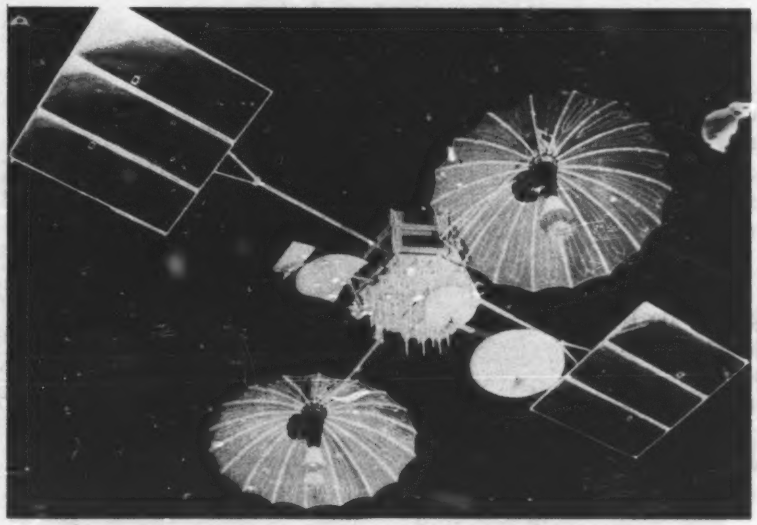
Operating at an average gross vehicle weight of 72,000 pounds, the truck turned in an impressive average fuel consumption rate of 5.25 miles per gallon for the nine trips. Its performance met test goals of the DOE Office of Transportation Programs in demonstrating reduced petroleum consumption while conforming to the more stringent 1980 California emission standards.

The truck was operated by Florida Refrigerated Services, Inc., of Dade City, Fla., as part of its scheduled freight service on the 5800-mile Florida-to-California round trip route. The truck's Kenworth tractor was selected from the carrier's regular fleet, the turbocompound engine having been installed at the Cummins facilities in Tampa.

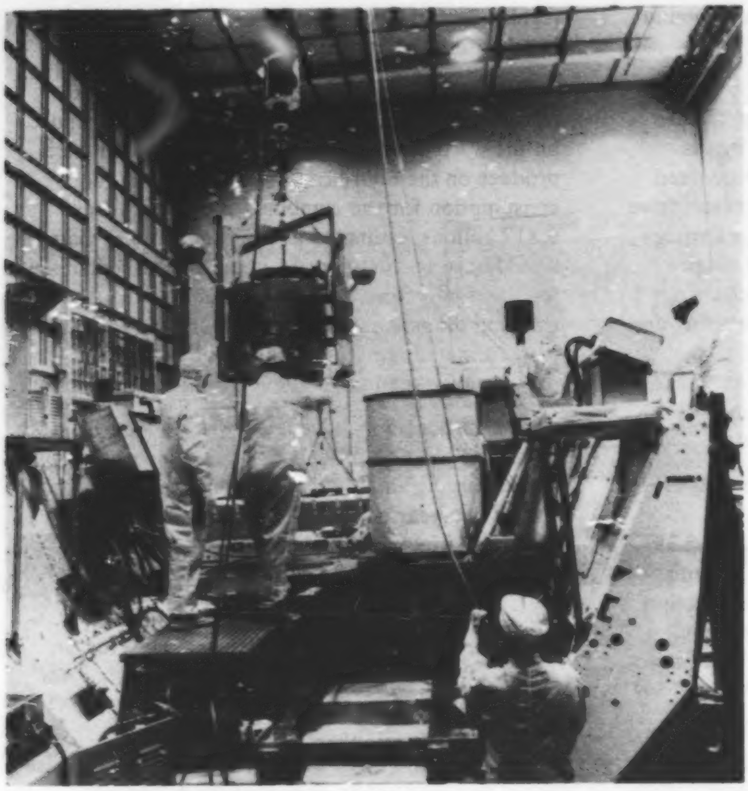
On its nine trips the tractor pulled a standard refrigerated trailer, loaded with frozen citrus juice on the westbound run to California and with fresh produce on the return trip to Florida. Total fuel consumption for the combined round trips was 9,817 gallons, estimated as four percent less than would have been required without the turbocompound feature. On a more demanding mountain route carrying the maximum legal load of 80,000 pounds, it is estimated that turbocompounding would provide a five-percent reduction in fuel consumption.

The turbocompound engine was derived from Cummins' 400-hp production model incorporating turbocharging and aftercooling, and was developed over a five-year period by Cummins at their Technical Center in Columbus.

In the search for further improvement in heavy-duty truck fuel economy, joint DOE/NASA/Lewis/Cummins development work calls for an advanced turbocompound engine to be ready for on-the-road vehicle testing by the middle of 1981. The fuel-consumption goal of the advanced turbocompound truck will be a five-percent increase in vehicle tank range, based on the 5.25 mpg average fuel consumption attained in the recent 50,000-mile demonstration.



Tracking and Data Relay Satellite System—Artist's concept of the Tracking and Data Relay Satellite System (TDRSS) will consist of two specialized relay satellites in synchronous Earth orbit and a ground terminal located at White Sands, N.M. These satellites will relay data, commands, video and voice to and from spacecraft and the ground terminal. The TDRSS spacecraft and ground station facilities will support NASA Earth-orbital scientific applications and manned spacecraft missions including the Space Shuttle Spacelab and automated spacecraft to be inserted in orbit by the Space Shuttle in the 1980's.



Plasma Diagnostics Aboard Shuttle— NASA scientists in the clean room at Goddard Space Flight Center, Greenbelt, Md., lower a plasma diagnostics package aboard a Space Shuttle pallet. The experiment, built by the University of Iowa under a NASA contract, will be flown on one of the early Space Shuttle missions. The 329-pound plasma experiment will be maneuvered outside the bay of the Space Shuttle in flight by a remote manipulator arm to measure the electromagnetic field around the spacecraft. Upon completion of the experiment, the robot arm will ease the instrument back into the bay for return to Earth aboard the Shuttle. A total of 8,200 pounds of experiments are being placed aboard this particular pallet which will be stored in a clean room facility until the flight.

Kelly Hosts Aerospace Symposium '80

NASA's Aerospace Symposium '80 was held March 12-14 at Kelly Air Force Base, San Antonio, Texas. The symposium was designed to motivate students—especially females and minorities—to seek careers in science and engineering.

More than 2200 students, teachers, and counselors participated in the three days of seminars and workshops. A tour of Kelly Air Force Base also was held.

Seminars were conducted by JSC and Headquarters scientists and engineers. Topics included: Exploring the Outer Planets; Astronomy; Benefits from Space Medicine; Space Shuttle Program; and Solar Power and Future Space Systems.

NASA astronauts Frederick D. Gregory, Terry J. Hart and Judith Resnick presented awards to students who submitted outstanding science papers prior to the symposium. The papers were judged by JSC scientists and engineers. The symposium was acclaimed as a huge success. The enthusiastic response was demonstrated by the submittal of 485 science papers by the students.

The mayor of San Antonio, the Honorable Lila Cockrell, declared March 12-14 as "NASA Aerospace Symposium '80 Days."

Astronaut Judith Resnick signing autographs at the Aerospace Symposium '80 held recently at Kelly Air Force Base, San Antonio, Texas.

Spacesuit Backpack Fire Investigated

A NASA board investigating the April 18 flash fire in a spacesuit backpack found where the fire started and recommended numerous ways to improve the safety and reliability of the system.

The fire apparently started when the technician switched the secondary oxygen pack to the operating position during a performance test in a clean room in the Crew Systems Laboratory. The secondary pack is attached to the bottom of the main backpack to provide 30 minutes of emergency oxygen for breathing and to maintain suit pressure if the main oxygen source fails. Ignition took place in a V-shaped passage which restricts the flow of oxygen between a shutoff valve and a chamber in the pack's regulator module.

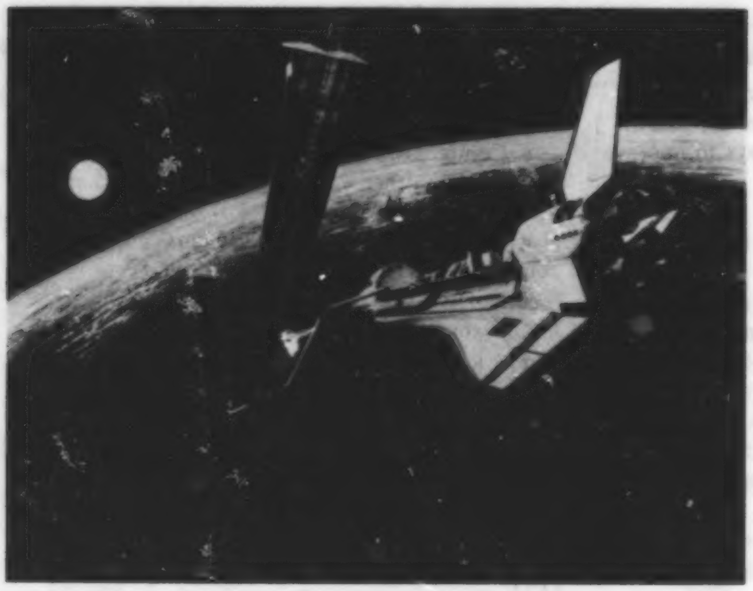
The board was unable to determine the exact cause of the fire after five weeks of engineering detective work that included more than 2,000 unsuccessful attempts to reproduce the fire. The board determined, however, the four most probable causes of the ignition and cited these in a report to Johnson Space Center Director Christopher C. Kraft, Jr.:

- Compression and/or shock heating in the flow restrictor between the shutoff valve and the capacitance volume, rupturing and igniting a thin section of aluminum.
- Compression and/or shock heating of contamination that was trapped in the stagnant volume of the flow restrictor.
- Mechanical heating of or by particulate contamination impinging on a surface.
- Compression and/or shock heating of one of the Silastic O-rings in the SOP shutoff valve.

The board found that all procedures followed during the April 18 test were proper. These tests are conducted to assure that malfunctions are discovered prior to flight, since such an accident during a mission might cause serious injury to the crew or damage to the space vehicle.

The regulator module contained 19 cycles of high-pressure oxygen prior to the accident. After ignition on April 18, the regulator module burned through and an oxygen-rich jet of flame burned the lower torso of the attached spacesuit. The board ruled out backpack and clean room electrical systems as ignition sources. It reported all clean room support feed lines were pure.

Two Ways To Go 50 Miles—Two vehicles in the vicinity of the Vehicle Assembly Building, Kennedy Space Center, Fla., are each capable of travelling about 50 miles on a single fill-up. But that's where the comparison ends. The most easily seen vehicle around the VAB (top right in photo) is the huge first stage of the Saturn V booster. Its five engines burned more than four million pounds of liquid propellants in two and a half minutes, burning out at about 50 miles from the launch pad as it lofted the upper stages and Apollo capsule moonward. The other and newer vehicle can also go about 50 miles from the launch area before it runs out of juice, but it's an electric van being tested at KSC to reduce rising energy costs. The mini-van, one of two recently delivered to KSC, uses conventional lead-acid batteries to power a direct current drive motor. The vans are expected to get about four miles to the kilowatt hour.



Shuttle Orbiter Solar Array System— Artist's concept of the Orbiter Solar Array System (OSAS), a solar panel designed to receive the Sun's rays and possibly add 22 days' life to a Shuttle mission. The OSAS would be deployed by the Shuttle's remote manipulator arm (shown in photo). Lockheed's Missile and Spacecraft Division and the McDonnell Douglas Corporation are working jointly on this study. When deployed, the system measures 80 m × 4 m (262 ft × 13 ft) but it collapsible to a stowage size of 1 m × 4 m (3 ft × 13 ft). The outer structure is constructed of fiberglass and the inner part is composed of a graphite epoxy material. The OSAS would be capable of producing a total output of 29 kilowatts of electrical power. This concept reduces the amount of liquid hydrogen and oxygen needed to run the fuel cells.

The accident destroyed an unoccupied Space Shuttle spacesuit and life-support backpack. A Hamilton Standard technician, Robert A. Mayfield, was severely burned but is recovering and has been released from the hospital.

Technicians were unable to duplicate the failure in tests at Johnson's White Sands Test Facility, Las Cruces, N.M. Four regulator modules of the same factory batch were cycled 2,228 times. Post-test disassembly revealed significant contamination within the modules.

A regulator module is machined from a single block of aluminum and is fitted with valves, a pressure gauge and two step-down regulators that reduce oxygen-supply pressure from 6,000 to 3.5 pounds per square inch. The flow restrictor, located between the high-pressure inlet and the first stage regulator, consists of two $\frac{1}{16}$-inch diameter drilled passages that intersect.

The safety improvement recommendations of the investigating board are:

- Redesign high-pressure oxygen valves and regulators so that debris cannot be trapped and eliminate "stagnation points" where heating by compression and shock can occur.
- Redesign regulator modules to lessen chance of internal contamination, while improving manufacturing inspection techniques.
- Review the design of all Space Shuttle high-pressure valves and regulators for debris traps and unprotected O-rings.
- Replace existing silicone O-rings with silicone O-rings having improved ignition resistance.
- Consider machining regulator module bodies from monel instead of aluminum to reduce ignition potential.
- Inspect completed regulator modules with X-rays.
- Consider using neutron radiography to confirm that O-rings and other non-metallic components with significant hydrogen content are properly installed.
- Machine a dummy regulator module body from a block of clear plastic to verify wall thicknesses and other passageway machining tolerances.
- Consider comparison impact ignition testing of Teflon or Kel-F backup rings as a means of reducing shock heating of silicone O-rings.
- Clarify internal NASA specifications.
- Consider establishing a committee consisting of NASA and non-NASA personnel to collect existing high-pressure oxygen data, review and clarify existing design standards and requirements, recommend any necessary supplements to presently available information and publish a comprehensive standard for the design and use of high-pressure oxygen equipment used in the spece program.

In reviewing the board's report, NASA Deputy Administrator Dr. Alan M. Lovelace complimented the thoroughness of the investigation and said that the board's recommendations to improve the safety and reliability of the system will be followed.

The investigating board was headed by Chester A. Vaughan, propulsion engineer. Members were: Noel Willis, Jr., crew systems engineer; George D. Nelson, astronaut; Joseph Degioanni, flight surgeon; and James H. Chappee, safety engineer. Andrew J. Hoffman of Hamilton Standard served as ex-officio member, and R. L. Johnston, materials engineer, served as advisor.

Automated Advisory System Demonstrated

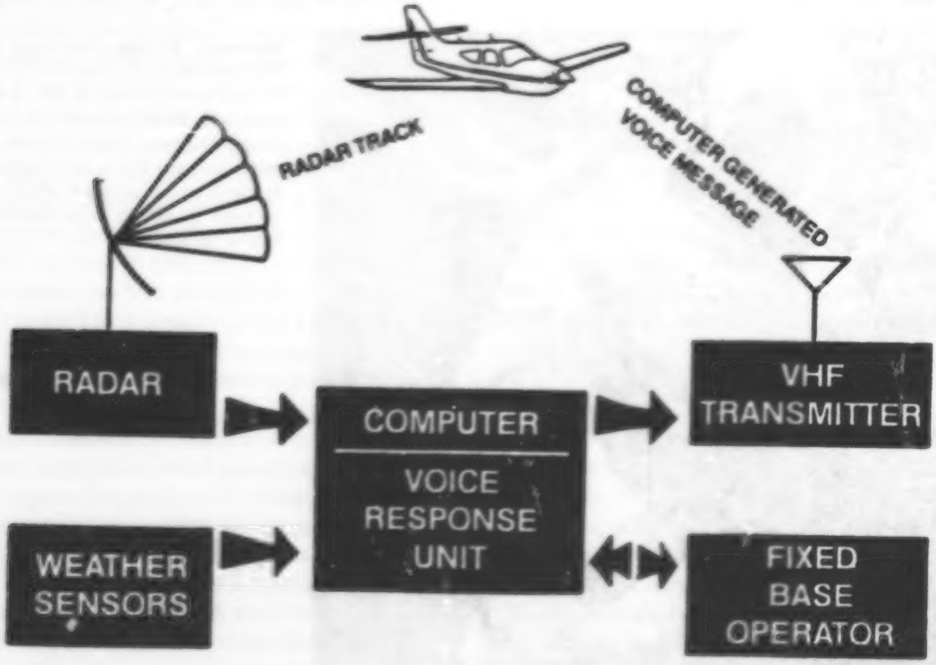
Flight demonstrations began in June at a Virginia airport of an experimental NASA computer advisory system which will expand the information available to pilots using smaller airports without control setups. The Automated Pilot Advisory System went into operation on June 23 at Manassas Municipal Airport, Va.

Designed as an extension of the procedural Visual Flight Rules system used at uncontrolled airports, the experimental system will help pilots keep track of other aircraft in the vicinity by supplying them with air-traffic information.

Computer-generated voice, radar and weather sensory information will broadcast automatically an airport advisory every two minutes and a traffic advisory every 20 seconds. To receive these advisories, the pilot need only to tune his radio to the proper frequency. The airport advisory will provide the airport identifier, broadcast time, wind speed and direction, favored or active runway, altimeter setting, and ambient and dew-point temperature. The traffic advisory will provide the number of aircraft on each pattern leg (final, base, downwind, crosswind or upwind), and position and heading of arriving or departing aircraft.

NASA's objective in performing the flight-demonstration tests at Manassas is to obtain an evaluation from pilots using the system in an uncontrolled high-density environment. The Manassas airport was especially suited for this demonstration because it is estimated that this airport handles approximately 200,000 operations per year—landings and/or takeoffs.

Principal elements of the experimental system are a radar set, a mini- and micro-computer, weather sensors, a very high frequency (VHF) transmitter and an operator control panel. The computers provide target detection and tracking, pattern classification, evaluation of weather-sensory data and generation of the several audio voice messages for transmission to aircraft.



Bauer Elected Corresponding Member

Dr. Siegfried J. Bauer, Goddard's Associate Director of Sciences, recently was elected a corresponding member of the Austrian Academy of Sciences.

Dr. Bauer, who was born and educated in Austria, has been working in the United States for the past 26 years. Prior to joining Goddard in 1961, he was Senior Research Scientist for the U.S. Army Signal Research and Development Laboratories, Fort Monmouth, N.J.

In addition to this present honor, Dr. Bauer is a Fellow of the American Association for the Advancement of Science, a Fellow of the American Geophysical Union, and a recipient, in 1974, of the NASA Medal for Exceptional Scientific Achievement.

L-1011 Vortex Flight Testing

Wake vortex flight testing with an L–1011 wide-body jet transport aircraft resumed June 9 at NASA's Dryden Flight Research Center, Edwards, Calif., in conjunction with the Federal Aviation Administration.

The tests, which will continue for several months, are aimed at reducing vortices, invisible turbulent air flows that stream in a tornado-shaped pattern from the flaps and wingtips of aircraft. For the wide-body class of aircraft, vortices can be severe enough to require time delays in takeoffs and landings at airports. As they also can interfere with other aircraft landing and taking off, planned time separations are currently imposed. If the vortices can be diminished, the reduction in traffic congestion could result in significant fuel and time savings.

Previous tests with a Boeing 747 transport indicate that it may be possible to break up vortices by selected use of the aircraft's ailerons and spoilers. The spoilers, which are normally used as speed brakes and to decrease the aerodynamic lift after landing, will be used in flight to disturb the vortices trailing from the wing flaps. The ailerons, which normally are used for turning, will be deployed to disturb the wing-tip vortices.

The L–1011 to be used in the tests is the Lockheed prototype certified with a direct-lift flight-control system that has the spoilers normally deflected at an upward angle of 8 degrees. The proposed vortex alleviation system is not greatly different from the present approved flight-control system already in use on the long range L–1011 aircraft.

The flight tests will consist of high-altitude probing of the vortices (marked by smoke generators) by

Buoyancy Testing—Astronaut Bruce McCandless in the neutralized gravity environment of the Neutral Buoyancy Simulator tank at NASA's Marshall Space Flight Center. The astronauts use the tank to evaluate methods and equipment which might be used to service large structural beams in space.

a small, highly instrumented NASA test aircraft. If the high-altitude tests are favorable, simulated landing approaches will be made to a runway on the dry lakebed at Edwards. A laser doppler velocimeter, radar-sensing system, and a ground-wind vortex-sensing system will be used to measure the trailing vortices in ground effect.

If the configuration changes to the L-1011 alleviate the vortices sufficiently, actual landings of the test aircraft at reduced separation distances will be considered.

Lewis Technology Transfer Conference

As many as 400 executives leading researchers, and others representing a cross-section of large and small business and industry in greater Cleveland and northern Ohio convened May 14 and 15 at the Lewis Research Center, Cleveland to learn of the latest in aerospace developments that promise potential for meeting growing energy and other technological needs of the nation in the years ahead.

Attendees of "Impact for the 80's: A Conference on Selected Technology for Business and Industry" were briefed on a variety of potential commercial application opportunities from aerospace-based technology. The energy options set forth in some of the leading presentations, if even partially realized, could help ease America's task of maintaining economic growth and a competitive position in world trade in the face of pervasive national and worldwide energy problems.

Most dramatic of these presentations were those on wind power commercialization and solar photovoltaics, both foreseeing bold new technologies in practical use in the next several years in many places around the country, some producing electric power at costs competitive with those of utilities. For example, the technology would permit thousands of high-capacity wind turbines to spin out power in "farms" of 50 to 100 turbines, each at strategically located sites, at costs averaging 3 to 4 cents/kilowatt hour. The Jet Propulsion Laboratory speaker presented a bright future for solar cells producing electric power in various parts of the country.

Studied optimism was conveyed in other conference presentations: progress in development of Stirling and gas turbine engines for greater fuel efficiency for motor vehicles; a prospective practical electric or hybrid car on the road in the 1980's; and production of electric power by a high-sulfur coal gasification/cogeneration process that eliminates pollutants while using otherwise-wasted heat to maximize system efficiency.

The attendance of some 450 for the proceedings was the largest local group ever to assemble for a technology utilization conference at Lewis. Many attendees shared a common interest in managing problems of energy use in the day-to-day conduct of their businesses. In this important respect the conference was a significant event in Lewis' productive relationship with business and industry.

Contractor News

Canadian Astronautics, Ltd., of Ottawa, has been selected by Goddard Space Flight Center for negotiation of a contract to provide Local User Terminals to process signals from the search and rescue instruments aboard orbiting satellites. The contractor's estimated cost is $3,042,500. The first terminal will be installed at Kodiak, Alaska. Optional units may be installed at Scott Air Force Base, Ill., and the U.S. Coast Guard Station at San Francisco, Calif. The first set of equipment must be installed within 19 months after contract signing. The contract also provides for 15 months of maintenance of each unit after installation.

Computer Sciences Corporation, Applied Technology Division, Falls Church, Va., was awarded a $36,782,578 one-year extension on its communications and instrumentation support services contract by the Kennedy Space Center. The extension is for a one-year period that began June 1, 1980. This action marks the fourth year of service and brings the total value of the contract to $106,851,713. The cost-plus-award-fee contract calls for CSC to provide communications and instrumentation services in support of the Space Shuttle program.

Lewis Research Center has awarded to **TRW's Defense and Space Systems Group,** Redondo Beach, Calif., and **Hughes Aircraft Co.,** Los Angeles, parallel $1-million one-year contracts to develop a design concept for an advanced commercial communications satellite system. The system would be operated experimentally in the high frequency 30/20 gigahertz (GHz) bands and is expected to prove technology concepts, that, if implemented commercially, would meet the tremendous increase in U.S. telecommunications needs anticipated during the next two decades. These bands have not been used commercially to date in this country.

Ford Aerospace and Communications Corp., Houston, has been selected by NASA for negotiation of a contract to perform the overall system design engineering of the Preliminary Operations Requirements and Test Support system for the Space Telescope. The contractor's estimated cost is approximately $9.2 million. The work is to be completed by December 1983 in time to support the Space Telescope Mission. Ford Aerospace will operate the system for six months before turning it over to NASA. Overall direction of the system is under the Office of Space Tracking and Data Systems at NASA Headquarters.

Rockwell International Corp., Downey, Calif., has been selected by NASA to conduct a design study of alternate thermal protection systems for the Space Shuttle Orbiter. The nine-month study is expected to cost approximately $900,000. The major goal of the study will be to determine if a more durable system, requiring less maintenance and a lower life-cycle cost, is or can be made available, based upon improvements in thermal protection system technology. Alternate systems to be studied will include metallic, ablative and reinforced carbon/carbon concepts. The contract will be managed by the Langley Research Center, Hampton, Va.

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January 17	Atlas Centaur	ESMC	DOD Navy. Reimbursable.
SMM-A	February 14	Delta	ESMC	NASA. Scientific Solar Maximum Mission.
NOAA-B	May 29	Atlas-F	WSMC	NOAA Weather. Reimbursable. Launch vehicle failed.
GOES-D	September 9	Delta	ESMC	NOAA Weather. Reimbursable.
SBS-A	October	Delta	ESMC	Satellite business systems. Reimbursable.
FLTSATCOM-D	October 28	Atlas Centaur	ESMC	DOD Navy. Reimbursable.
NOVA 1 (Navy 20)	November	Scout	WSMC	DOD Transit. Reimbursable.
Intelsat V-A	November	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Vincent G. Anicich, Wesley T. Huntress, Jr., Caltech/JPL	Miniature cyclotron resonance ion source using small permanent magnet	4,206,383	NRO/JPL
Porter R. Ryason, Caltech/JPL	Continuous coal processing method and means	4,206,713	NRO/JPL
Roland W. Lee, NASA/Langley	Retainer for murine specimens and test equipment	4,206,721	LaRC
William M. Hahlbaum, Jr., NASA/Langley	Chromatically corrected virtual image visual display	4,206,970	LaRC
Robert C. Bill, Lawrence P. Ludwig, NASA/Lewis	Composite seal for turbo-machinery	4.207.024	LeRC
Paul M. Sawko, NASA/Ames	Structural wood panels with improved fire resistance	4,209,561	ARC

Did You Know?

Two new NASA special publications have been released: "Volcanic Features of Hawaii: A Basis for Comparison," by M. H. Carr and R. Greeley (NASA SP-403), and "The Apollo Spacecraft: A Chronology—Volume IV: January 21, 1966–July 13, 1974," by I. D. Ertel and R. W. Newkirk, with C. G. Brooks (NASA SP-4009). "Volcanic Features" serves as a photographic guidebook to the volcanic features of Hawaii and Mars. As the book emphasizes the photography, the text is deliberately short. The book opens with a brief overview of Hawaiian volcanoes followed by several chapters illustrating different features of that state's volcanic structures. The book's second half covers Martian geology and volcanic features. This casebound book is 218 pages and contains 175 black and white photographs. It is for sale by the Superintendent of Documents, U.S. Government Printing Office, for $14. "Apollo Spacecraft" is the final volume from the Johnson Spacecraft Center and details the chronological history of the major events and managerial decisions that culminated in the Apollo spaceflight program. Volume IV covers the period from January 21, 1966 through July 13, 1974—a timeframe during which the following events took place: all flight tests of the Apollo spacecraft, the last five Gemini flights, the tragic fire that claimed the lives of three astronauts, the manned Apollo flight program and its results, and the use of the Apollo spacecraft for the Skylab missions. This paperbound book is 482 pages and is for sale by the Superintendent of Documents, U.S. Government Printing Office, for $11.

NASA has instituted a **flight equipment data bank.** The computer listing provides a reference and point of contact for identifying space equipment currently flight-qualified or -qualifiable which may be used for future space experiments, reducing the cost for new development efforts. Listings do not imply NASA endorsement. Equipment listed includes items that have been launched or successfully flight qualified within the last two years or which are under contract with a projected launch date and will be flight qualified prior to that time. The listing includes the mission with which the equipment is associated, the date of launch and the manufacturer. Users requesting this information should write the Office of the Chief Engineer, NASA, Washington, D.C. 20546. Companies which manufacture flight-qualified or -qualifiable equipment can obtain information on registering these items by writing to the above address, or by calling Ben Bernstein, Assistant Manager, Parts and Materials Program, Program Assurance Division, Office of the Chief Engineer 202/755-3290.

Idea Clearinghouse, an internal voluntary pilot program designed to spread the word on good management ideas, this month cites the Ames Research Center's Procurement Management Technology Program, an automated purchase order information system developed by the Headquarters Office of Procurement. The program enhances procurement operations by taking advantage of the latest data-processing techniques. Joe Rokovich of Ames Procurement Division explains that the information system allows users at remote terminals to query the controlled data base for the status of purchase requests for dates of award or delivery, as well as other variables, by following a programmed set of instructions. Another currently operational feature uses a high speed printer that eliminates the manual preparation of purchasing documents. The Photographic Technology Branch at Ames is one satisfied user enjoying the benefits which result from faster response times to questions on the status of purchases for their many customers. (For more information contact Headquarters: Dr. Neil Lamb, FTS 755-2060 or the Information Systems Division, 755-3219.)

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Foldable Walker

Paraplegics, who number about 100,000 in the United States, depend on crutches for their mobility on level ground. But crutches are ineffective on stairways; for climbing or descending, the paraplegic needs a stable pair of rails to push against. Aluminum metal walkers are designed for use on level surfaces, hence they have little utility on stairs; and, although lightweight, they are too heavy to be carried by the paraplegic while walking on crutches. There exists a need for a walker specifically designed for stair use and made of a material much lighter than aluminum.

Engineers at Langley Research Center teamed with Dr. Ernest Harrison of the Mississippi Methodist Rehabilitation Center in a community service project involving development of a very light walker that is foldable for easy carrying. The prototype stairwalker * is based on composite materials being developed by NASA for aircraft and spacecraft. The material selected was a graphite-epoxy composite which is stronger yet 50 percent lighter than aluminum. The developers made the front legs eight inches longer than the rear legs to fit the uneven surfaces of a stairway.

Dr. Cynthia Morris (shown in photos), a professor at American University, Washington, D.C. and a paraplegic, has been evaluating the composite foldable walker for more than a year. She reports that it is light enough to carry while walking on crutches, it forms a stable platform to assist her in ascending and descending stairs, and it has significantly improved her mobility and independence.

National Aeronautics and
Space Administration

For the benefit of all . . .

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of such technology.

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NASA Activities

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COVER

Wind Power Terminal—Above the North Carolina hills at Boone, a technician perches atop the world's largest wind turbine generator. The Boone windmill was introduced to service last year as a major system in the Department of Energy/NASA program to harness this age old source for generating electricity and pumping water. Computer controlled, the machine uses its 200-foot rotor to convert wind force into electrical energy, producing two million watts at optimum wind speeds of 25 miles per hour. Recently, because of complaints by nearby residents, the DOE and NASA's Lewis Research Center have had to stagger operations in order to hold down the steady noise from the turbine and its vibration effects. Despite such minor problems, wind power as an attractive energy source continues on the rise. The newest 200-kilowatt wind turbine was dedicated in Hawaii in July and it is now capturing ocean breezes off the north shore of Oahu; smaller machines will be installed in Washington state late this year as part of the Bonneville Power System.

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Shuttle Goes March 1981

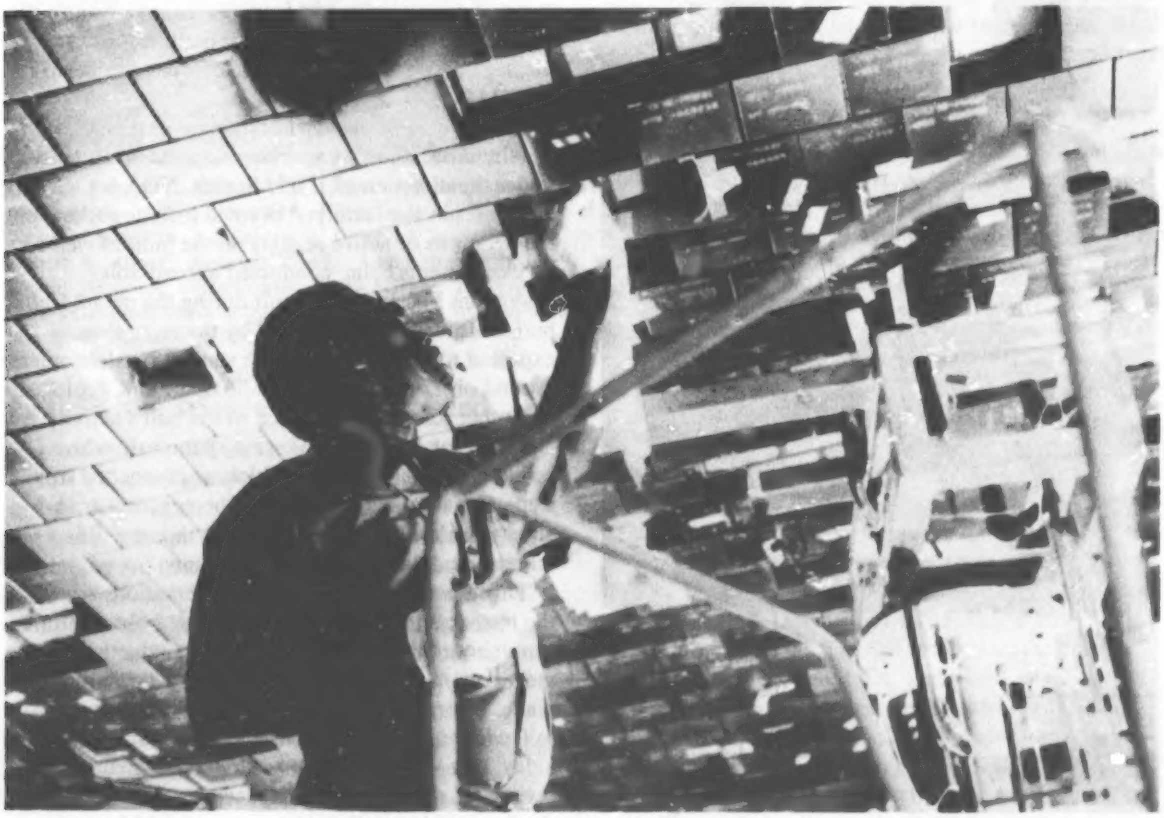
NASA has confirmed a decision made earlier this year to schedule the first Space Shuttle launch in March 1981. The announcement follows an intensive review of the Space Shuttle program carried out over many weeks. Dr. Robert A. Frosch, the NASA Administrator, said the decision to continue to drive toward a March launch was made even though the Shuttle program received a potentially serious setback July 30 when fire damaged a Shuttle engine during a test in Mississippi.

Frosch said a separate study of the cause of the engine fire and its possible impact was underway but that the engine study would not be allowed to impede the central effort to hold to the agreed-upon launch schedule.

"Our exhaustive program review led us to the conclusion that we can set a difficult but achievable schedule leading to a first launch in March," Frosch said. "The engine failure could affect that decision, but we will make every attempt to assure that it does not. I am counting on the commitment and hard work of everyone in the program to reach a March launch date."

The decision by NASA to commit to the March launch schedule came after a series of meetings where NASA and contractor personnel examined the status of preparation of the hardware and software required for the first flight. Also examined was the progress being made on certification of engines; the results of a number of recommendations made by 13 special teams carrying out independent assessments of the flight certification program; the progress being made on Launch Complex 39 at Kennedy Space Center, Fla.; mission planning, crew training and the readiness of the communications and tracking network which will be used during the Shuttle mission.

Columbia, the Shuttle orbiter being prepared for the first flight, is expected to leave the Orbiter Processing Facility at Kennedy Space Center Nov. 23 after necessary work on the thermal protection system has been completed. Other work to be accomplished on Columbia while it remains in the processing facility includes minor structural

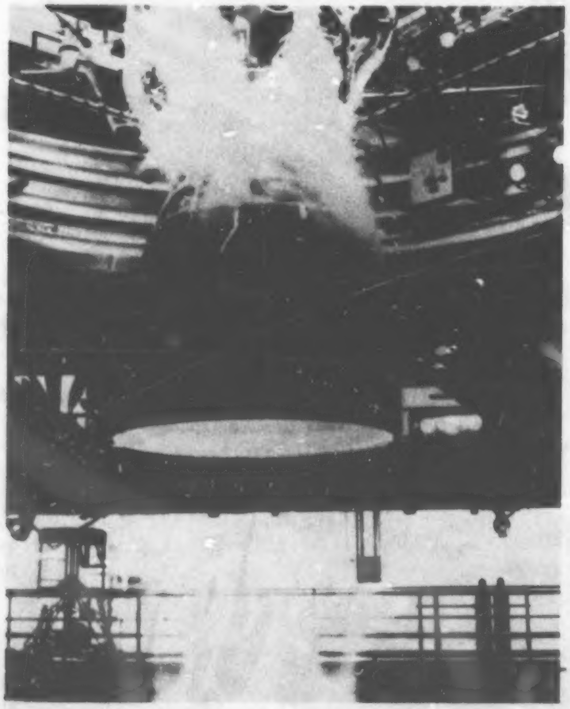


Some of the 34,000 tiles that will fly with the Shuttle and absorb the intense heat of reentry.

modification to the orbital maneuvering system pods, other subsystem modifications and completion of orbiter checkout. The Manned Maneuvering Unit and Tile Repair Kit are not now scheduled to be flown on the first flight.

After Columbia leaves the Orbiter Processing Facility, a 15-week work schedule has been established leading to a March launch. Columbia will move first to the Vehicle Assembly Building at Kennedy Space Center where it will join the solid rocket boosters and the external tank and undergo an integrated test in preparation for its journey to the launch pad. After the Columbia arrives at Launch Complex 39 Pad A, it will undergo another extensive series of tests to assure compatibility between flight and ground systems in preparation for the Flight Readiness Firing, scheduled for February.

The firing, during which the main engines will operate for 20 seconds, will constitute both a validation of system readiness and a full dress rehearsal of the countdown to take place in March. During the approximately five weeks between Flight Readiness Firing and the launch itself, all of the data from the test firing will be thoroughly analyzed, together with the final results of the flight certification program.



Engine 0006 will be on the first manned orbital flight.

In discussing the 15-week work schedule from Orbital Processing Facility rollout to launch, Frosch said, "Experience from previous first launches of new vehicles tells us that original work schedules are seldom carried out in the time planned and may take several weeks longer. However, that same experience also tells us that the best chance of the earliest successful first flight comes in working to a tight but achievable work schedule."

Solar Flare "Hotline" Service

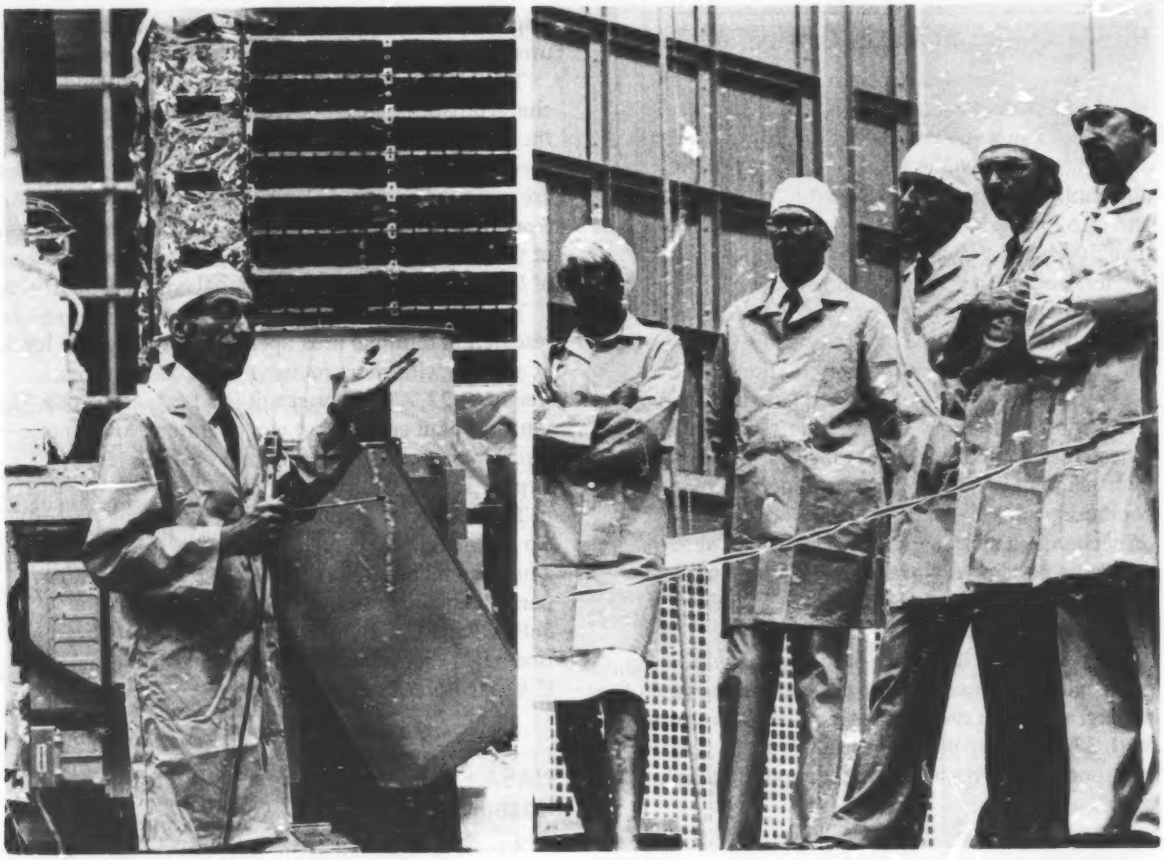
A "hotline" designed to inform the public of solar flares erupting on the Sun during this year's peak cycle of activity has been inaugurated at Goddard Space Flight Center. The "Solar Max" hotline service is being provided jointly by NASA and the National Oceanic and Atmospheric Administration through the latter's Space Environment Services Center in Boulder, Colo.

Information on sunspots, solar flares, geomagnetic storms and the impact of the Sun's behavior on radio transmissions will be provided in daily recorded messages from Goddard. The telephone number is 301/344-8129.

The daily recordings will originate in the Solar Maximum Mission's Experiment operations facility, under the direction of David Speich, NOAA forecaster in the facility. They will include reports on the locations of active regions on the Sun, as well as on experiments being conducted aboard Solar Maximum Mission spacecraft during the next 24-hour period. Information provided by the recordings is expected to serve as a valuable source to astronomers, ground observers, amateur radio operators, geologists and other scientists interested in the Sun's activity.

The Solar Maximum Mission spacecraft is an orbiting solar observatory which was launched from Cape Canaveral last Feb. 14. The spacecraft, in an equatorial orbit, circles the Earth every 96 minutes and carries seven instruments.

Through the coordination of observations from the instruments and from ground-based observatories throughout the world, scientists are conducting the most comprehensive investigation of solar flares ever made. Information from these sources is relayed to Goddard on an up-to-the-minute basis, 24 hours a day, seven days a week. At Goddard, scientists review the data and determine what active regions of the Sun will be studied during the next 24 hours.



Officials Briefed on OSS-1—Dr. Werner Neupert, Mission Scientist, briefs representatives of Headquarters and the press at Goddard on the first scientific payload to fly on the Shuttle. In group at right are (L to R) Dr. Adrienne Timothy, Assistant Associate Administrator, Office of Space Science; Dr. Thomas A. Mutch, Associate Administrator for Space Science; Robert F. Allnutt, Associate Deputy Administrator; Jesse W. Moore, Solar Terrestrial Division; and Andrew J. Stofan, Deputy Associate Administrator, Space Science. The briefing was held in Goddard Building 7 Clean Room where the OSS-1 payload is being checked out. At Neupert's left may be seen a part of the Goddard Thermal Experiment, one of six which will fly on OSS-1.

First Shuttle Science Payload Unveiled

The first scientific and applications payload for NASA's Space Transportation System was displayed in July at Goddard Space Flight Center. Details of the seven principal experiments were provided and briefings were held in Goddard's Clean Room, where instruments were installed in the payload currently planned as an alternate on Orbital Test Flight 4, scheduled for April 1982. The prime payload scheduled for this flight is a Department of Defense project.

Primary objective of the test flight mission is to evaluate performance of the Shuttle systems in planned modes of operation and to measure the environments associated with operation of the Space Transportation System. Its secondary objective is to provide early demonstration and verification of Space Shuttle's research capabilities for science, applications and technology.

Experiments on OSS-1 cover the disciplines of space plasma physics, solar physics, astronomy and life sciences, all of which are represented by one or more instruments.

Named OSS-1 for its NASA Headquarters originators, the Office of Space Science, the entire payload was designed, built, tested and integrated by a team of Goddard engineers and scientists headed by Ken Kissin, OSS-1 Mission Manager, and Jon Busse, Shuttle Payoads Integration and Rocket Experiments Project Manager. Drs. Siegfried Bauer and Werner Neupert are the Project Scientists.

Research Aircraft Makes Carrier Landings

The Quiet Short-Haul Research Aircraft (QSRA) has successfully landed on the U.S. aircraft carrier Kitty Hawk in waters off San Diego. It was the culmination of a Navy/NASA investigation of the application of propulsive lift technology to carriers and it followed an intensive six-week exercise. More than 500 landings were made on a simulated aircraft carrier deck before the real thing.

Working under a tight schedule, NASA and the Navy included in the program a checkout of two Navy pilots in the aircraft; determination of the best method of landing a large airplane like the quiet, short-haul model on an aircraft carrier; and repeated simulated carrier landings by the Navy pilots and NASA research pilots under various conditions to obtain statistical data on touchdown dispersion and sink rates. The simulations were made at Crows Landing a Naval Auxiliary landing field southeast of NASA's Ames Research Center, Mountain View, Calif.

A Fresnel lens, like those used aboard ship to guide pilots, was used for the tests, and an outline of an aircraft carrier deck was painted on the runway. With 37-kilometer-per-hour headwinds the research transport achieved touchdown at about 84 km/hr, a speed slow enough that arresting gear normally used on aircraft carriers is unnecessary.

Touchdown on Kitty Hawk—The Quiet Short-Haul Research Aircraft (QSRA) caps a six-week Navy/NASA test program by landing on the U.S. aircraft carrier Kitty Hawk off San Diego. The QSRA is the first four-engine transport jet to operate from a carrier at sea. Due to its slow approach speed (65 knots), the propulsive lift airplane is able to land without needing an arresting gear. This full stop landing, one of 16 made aboard the Kitty Hawk, followed more than 500 simulated carrier landings ashore.

The high-performance short-takeoff-and-landing characteristic of the research aircraft is a result of the upper surface blowing propulsive-lift technique used in its design. Four acoustically treated jet engines are mounted on top of the wing so that the fan air from the engines is directed across the upper surface of the wing and flaps to create very high levels of lift as compared to conventional wings.

The aircraft was built as a flight facility for research in terminal area operations at low noise levels at airports with short runways. At a design gross weight of 22,700 kilograms, it is a large craft with four turbofan engines but can operate at lower noise levels than most of today's small business jet airplanes.

The research aircraft was built by Boeing Aircraft Co., Seattle, under a NASA contract. It is essentially a new model but it makes extensive use of existing parts, including a fuselage shell and tail from a deHavilland C-8 Buffalo, landing gear parts from a Boeing 727 jet transport, and engines from the U.S. Air Force A-9A prototype aircraft project.

NASA Exhibit at Farnborough Highlights Research

Advanced research supporting development of safer, environmentally compatible, fuel-efficient aircraft are highlighted in the NASA exhibit at the Farnborough International 80 Airshow, Sept. 1-7 at Farnborough, England. With the theme "Toward Year 2000," the exhibit outlines NASA's aeronautical research and technology developments in fluid physics, propulsion, materials, structures, electronics and human factors.

Exhibits include transport technology research efforts to reduce fuel consumption by up to 50 percent in future subsonic aircraft, to enhance safety and to improve flight management efficiency.

Other transport projects include research directed toward possible future economically-viable, environmentally-acceptable aircraft capable of supersonic cruise flight and trans-Pacific range.

On display are systems and concepts supporting development of efficient rotary-wing craft for future civil and military applications, such as the NASA/Army XV-15 Tilt Rotor Research Aircraft which takes off and lands like a helicopter, but cruises like a conventional aircraft at better than 555 kilometers per hour.

Also exhibited are programs to improve the energy efficiency, environmental characteristics and utility of private and business aircraft. Projects include aircraft stall-spin prevention, crashworthiness testing, turbofan and reciprocating engine research, and advanced propeller designs.

NASA's Automated Pilot Advisory System for uncontrolled airports is depicted. The system provides computer-generated voice broadcasts, over standard radio frequencies, on local aircraft traffic, weather and operational data.

NASA Delegation Back From China

An aeronautics delegation, headed by Dr. Alan Lovelace, NASA Deputy Administrator, returned in July after two weeks in China visiting aeronautical research and development facilities. Invited to make the trip by the Chinese Aeronautical Establishment, the group met with Chinese colleagues and lectured on NASA aeronautical R&D activities.

NASA then invited the Chinese Establishment to send a delegation to the United States for a similar visit in September. The Chinese delegation is to visit NASA Headquarters, NASA research centers specializing in aeronautics, and other aeronautical research and development complexes.

Following that return visit, the space agency and the Chinese intend to explore possibilities for cooperation in aspects of aeronautical research and development that are of mutual interest.

Members of the U.S. delegation were: Dr. Lovelace; Dr. John F. McCarthy, Director, NASA Lewis Research Center, Cleveland; William S. Aiken, Jr., Chief Engineer, Office of Aeronautics and Space Technology, NASA Headquarters; Dr. William F. Ballhaus, Director of Astronautics, NASA Ames Research Center, Mountain View, Calif.; Roy V. Harris, Chief, High-Speed Aerodynamics Division, NASA Langley Research Center, Hampton, Va.; Richard A. Rudey, Chief, Aerothermodynamics and Fuels Division, NASA Lewis Research Center; Dr. Leonard A. Harris, Manager, Materials and Structures, Research and Technology Division, Office of Aeronautics and Space Technology, NASA Headquarters; James L. Copeland, Head, Simulation and Application Section, NASA Langley Research Center; Dr. (Col.) Norris Krone, Jr., Director, Air Vehicle Technology Office, Defense Advanced Research Project Agency; and Peter G. Smith, International Relations Specialist, International Affairs Division, NASA Headquarters.

Compliments of NASA—Dr. Benjamin Hooks, Executive Director of the NAACP, left, accepts a model of the Space Shuttle from Isaac T. Gillam, IV, Director of the Dryden Flight Research Center, at the NAACP's 71st Annual Conference in Miami Beach. Gillam, the highest ranking black in the space agency, attended the Conference to take part in the Commerce and Industry show.

X-rays from Jupiter

Scientists studying data from NASA's second High Energy Astronomy Observatory have confirmed the emission of X-rays from Jupiter. The giant planet thus joins Earth as the only planets known to produce X-rays. The emission was confirmed by a team of scientists led by Dr. Albert Metzger of the Jet Propulsion Laboratory and the group's findings were reported by Metzger at a meeting of the American Astronomical Society at the University of Maryland, College Park.

The discovery is expected to add to our knowledge concerning the belts of trapped, energetic, charged-particle radiation which surround the planet, and could provide new information on the surface composition of Jupiter's large moons.

The observations were made using the focusing X-ray telescope on the Earth-orbiting satellite, launched Nov. 13, 1978, which is managed by NASA's Goddard Space Flight Center. The telescope operates in space because X-rays cannot penetrate far enough into Earth's atmosphere to be observed from the ground.

According to Metzger, X-rays may be produced in Jupiter's atmosphere the same way they are produced in Earth's, by energetic electrons that spiral into the atmosphere from the trapped radiation belts as a result of interactions between the trapped particles and the planet's magnetic field. The energetic particles collide with atoms and molecules in the atmosphere, producing a broad band of radiation that includes visible auroras, ultraviolet light and X-rays. Observations of Jupiter's auroras by the Voyager 1 and 2 spacecraft suggest that the X-rays, like the ultraviolet light, emanate from the planet's polar regions.

The X-ray observations are an indication of how much power it takes to maintain the intense radiation belts in Jupiter's magnetosphere. The belts are contained by the action of Jupiter's strong magnetic field, which also acts to shield the surrounding region from the influence of the solar wind. From the X-ray brightness observed, scientists calculate that nearly one quadrillion watts of power are dissipated by energetic electrons being absorbed in the Jupiter system. In order to maintain the radiation belts, an equal amount of power must be supplied from the planet's rotational energy and from the force of the solar wind.

It is also possible that X-rays are produced by energetic ions and electrons bombarding the surfaces of satellites orbiting within the Jovian radiation belt. Observation of these X-rays could be used to determine the composition of the surfaces of the satellites Io, Europa, Ganymede and Callisto.

Besides Metzger, scientists involved in the search for Jovian X-rays were Dr. Joe Luthey and Dr. David Gilman of the Jet Propulsion Laboratory; Dr. Kevin Hurley of the Center for the Study of Space Radiation in Toulouse, France; Dr. Herbert Schnopper and Dr. Frederick Seward of the Smithsonian Astrophysical Observatory in Cambridge, Mass.; and Dr. James Sullivan of the Massachusetts Institute of Technology, Cambridge.

ARC Photo Shop Cited

Idea Clearinghouse, the Headquarters program to further management innovations, this month recognizes the Ames Photographic Information Center, now over one year old. The Center contains information on all still photographs on file since 1940, dating back to the just-opened Ames Aeronautical Laboratory in the days of NACA.

The system provides easy access to all material and very little experience is needed to retrieve information from one of the two microfiche indexes in use. Reference is made to either the number of the negative or by the use of any key word in the main title. And these indexes are periodically updated.

The user can quickly determine the number of negatives for a given title series, whether these are black and white or color, and whether the quality is suitable for display or exhibition. Special printouts may be obtained by organization code. A selected photo which has been microfilmed can be viewed on a reader-printer simply by entering the frame at the keyboard.

Previously, old data was entered into the memory disc by keypunching cards from edited log sheets. Conversion has resulted in eliminating about 55,000 cross reference cards, 4,000 pages of log sheets, and a five month backlog in typing file cards. Search and retrieval manpower has been reduced to 25%.

If you would like to know more about this idea call Ames/Roland Michaelis (FTS) 8-449-5017. If you have an idea you would like to see in the Idea Clearinghouse, contact Code NSM at Headquarters.

AIAA Section Head—Betty K. Berkstresser of Ames Research Center now chairs the San Francisco Section of the American Institute of Aeronautics and Astronautics, the first woman to hold that position. Berkstresser is a technical manager for the Flight Systems Research Division at Ames. She has a B.S. in mathematics and an M.S. in engineering, both from the University of Houston, and is currently completing other graduate work at Santa Clara University.

Negotiations Begun for Chemical Module

Marshall Space Flight Center, has selected Ball Corp., Ball Aerospace Div., Boulder, Colo., for negotiations leading to a contract for the design, development and manufacture of a self-contained, free-flying chemical release module for the first controlled, large-scale investigations of the dynamic phenomena which occur in the regions outside Earth's atmosphere. The contract calls for delivery of the module to Marshall Center for a mid-1983 launch of the Space Shuttle. The approximate value of the proposed contract is $9.5 million.

Scientists have, for many years, theorized that solar winds, solar flares and other phenomena originating on the Sun, directly affect our atmosphere through a series of dynamic processes in the Earth's magnetosphere, ionsphere and upper atmosphere. The difficulty in gathering information on these processes lies in the vastness of the region and the fact that all of this dynamic activity is invisible.

Certain chemical elements released in space will become visible because they absorb sunlight and reflect distinctive colors. Other chemicals react with oxygen particles in the upper atmosphere and glow. Motion of the atoms and ions, thus colored, can be tracked optically from the ground. These colors covering the heavens, especially during the twilight hours, will be a spectacular display to the average citizen. But, to scientists, seeking to unravel the mysteries of space plasma physics, it will be an unprecedented opportunity to gain invaluable knowledge that will eventually benefit mankind.

During the six-month lifetime of the module, 20 to 30 chemical releases will be made. Scientists will observe visually, as well as record the resulting phenomena with still cameras, television and motion picture film, and radar systems. Cameras will be both ground-based and airborne in a high-altitude plane, and observers will be dispersed in many locations so that photos and film from different angles can be correlated. In addition to scientists, amateur observers will be invited to participate in the project by photographing the phenomena from their own locations. To assist interested amateurs, NASA plans to publish an Amateur Observers Manual that will explain the project and among other data, give information on camera settings, film, angles, light, etc.

NASA Headquarters in Washington will invite scientists to participate through an announcement of opportunity, explaining that the chemical release module is a NASA facility for controlled releases of chemicals in experiments proposed by scientists. It will be available to scientists without their having to build expensive experiment hardware and, therefore, within the reach of many who would otherwise be prevented by costs from having their experiment conducted in space.

Weiss to Head Operations Office

Dr. Stanley I. Weiss, Deputy Assistant Secretary for Industrial and Utility Applications and Operations at the Department of Energy, has been named Associate Administrator for Space Transportation Operations at NASA Headquarters. He will be responsible for NASA's Space Transportation Systems operations and functions including scheduling, manifesting, pricing and launch service agreements for the Space Shuttle, the Spacelab program and NASA's expendable launch vehicles, which will continue to provide orbital booster and injection services during the transition to the Shuttle.

Prior to his appointment to the Department of Energy in the fall of 1978, Weiss was with Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif., since 1957.

At Lockheed he most recently served as Vice President, Advanced Programs and Development. This followed positions as Vice President of Engineering, Assistant General Manager, Programs, and Program Manager for several research and development programs for Department of Defense and NASA. He also held management roles in manufacturing and quality assurance. Earlier, he was Chief Engineer with the Kawneer Co., Niles, Mich., and Goodyear Aircraft Corp., Akron, Ohio.

Weiss graduated from Rensselaer Polytechnic Institute, Troy, N.Y., with a bachelor of science degree in 1945. He received his master of science degree at Rensselaer in 1947 and a doctorate in theoretical and applied mechanics at the University of Illinois, Urbana, in 1949.

Weiss replaces Glynn S. Lunney who has been Acting Associate Administrator since November. Lunney will return to his position as manager of the Space Shuttle Payload and Integration Development program at NASA's Johnson Space Center, Houston.

Weiss is married and has four children.

Griffin is Acting Head, External Relations

Gerald D. Griffin, Deputy Director of the Kennedy Space Center, has been named Acting Associate Administrator for External Relations at NASA Headquarters. Prime responsibility in his new position will be the policy level management, direction and coordination of the NASA Office of Public Affairs, International Affairs, DOD Affairs, Government/Industry Affairs and University Affairs.

Griffin joined NASA in 1964 at the agency's Johnson Space Center, Houston. He was a flight controller and, later, a flight director during the Gemini and Apollo manned flight programs.

In 1973 he was named Assistant Administrator for Legislative Affairs at NASA Headquarters, a post he held until 1975 when he was made Deputy Associate Administrator (Operations) in the Office of Manned Space Flight.

In 1976, Griffin was named Deputy Director of the NASA Dryden Flight Research Center, Edwards, Calif. He was transferred to his current post in 1977.

After graduating from Texas A&M University, College Station, and prior to joining NASA, Griffin spent four years on active duty as an Air Force officer and was an aeronautical engineer with the Douglas Aircraft Co., Long Beach, Calif.; the Lockheed Missile and Space Co., Inc., Sunnyvale, Calif.; and General Dynamics Corp., Fort Worth Div.

Griffin and his wife, Sandy, have two children.

McElroy Named Deputy at GSFC

Dr. John H. McElroy, director of the Communications Division of the Office of Space and Terrestrial Applications at NASA Headquarters in Washington has been named Deputy Director of NASA's Goddard Space Flight Center, Greenbelt, Md., effective Sept. 7, 1980. McElroy will succeed Robert E. Smylie, who has become NASA's Associate Administrator for Space Tracking and Data Systems at Headquarters. McElroy has been with NASA since 1966, when he joined the Goddard center and directed research on laser heterodyne systems for communications, tracking and radiometry and advanced satellite communications technology.

Before joining NASA, McElroy served in the Quantum Electronics Research Laboratory of the University of Texas at Austin where he participated in research on laser-induced ionization of high-pressure gases.

Earlier he was an electronics instructor and technical writer on various U.S. Army air defense guided missile systems, and was twice named instructor of the year for the U.S. Army Air Defense School, Fort Bliss, Texas. Prior to that, he served with a number of airborne infantry organizations.

McElroy is a 1954 graduate of Culver Military Academy, has a bachelor's degree from the University of Texas at Austin and a master's and doctorate from the Catholic University of America. He has been elected to Eta Kappa Nu, Tau Beta Pi and Omicron Delta Kappa, and is a Senior Member of the Institute of Electrical and Electronic Engineers and an Associate Fellow of the American Institute of Aeronautics and Astronautics.

He is married to the former Eleonore Hildegard Schmidt of Augsburg, Germany, and they live in Crofton, Md.

KSC Procedures Attract Nuclear Party

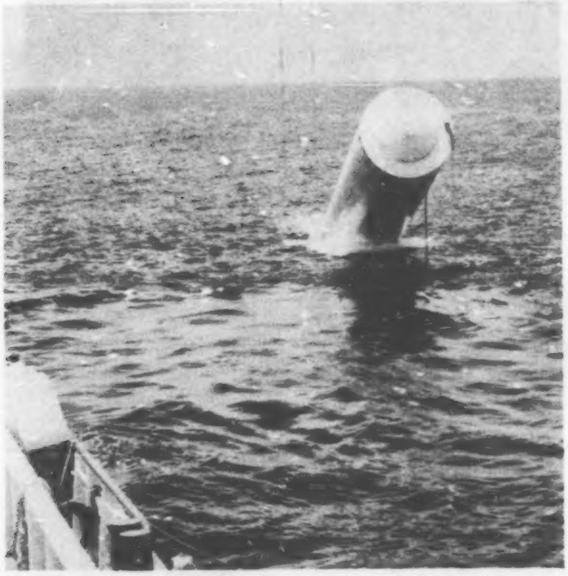
Nuclear Regulatory Commissioner Joseph Hendrie recently led a fact-finding team in a visit to the Kennedy Space Center to discuss techniques and operation procedures developed at KSC and how they might be used to assure the safe construction and operation of nuclear power plants.

Commissioner Hendrie, Ron Satterfield, Voss Moore and Dominic Tondi of the NRC were briefed on virtually all aspects of center activities and concluded that KSC is using various procedures that show potential for use in nuclear industry. Control room technology was one of the areas discussed. The nuclear facility and launch center are similar in that both have a central area—a control room or firing room—where all critical systems are monitored and controlled. Whether a system monitors fuel-line pressures aboard a space vehicle or temperatures in a cooling tower, a highly-reliable manner of operation is needed when handling dangerous materials.

Hendrie said that some nuclear facilities have the same traditional control room as the coal or oil-powered plants. The acceptability of these control rooms is now in doubt, in the aftermath of the Three Mile Incident. The NRC feels that KSC might provide some good suggestions on which space-age design and operating procedures might be put to use in control rooms to operate the highly sophisticated equipment of a nuclear power plant.

The Commissioner was quick to add that control room safety goes beyond detailed procedures and sophisticated equipment. "Three Mile Island forced us to look at the human factor—the integration of power plant instrumentation and control systems with human operators," he said while citing KSC's Launch Processing System, which enables a single person to process and monitor a large amount of information without being strained beyond his limitations.

The NRC visit was organized by Don Page, Chief of the Electronic Engineering's servicing systems Section at the Kennedy Center. Page has been invited, as a result of the visit, to conduct additional discussions on design and system assurance at the NRC's Washington office.



Simulator in Sea Test—Resembling a blunt version of the central character in "Jaws", a full-scale mockup of a solid rocket booster casing breaks the surface in Cape Canaveral waters. The simulated Space Shuttle booster is being drained of water by recovery crews, allowing it to rotate to a horizontal position for towing to port. Testing of equipment that will be used for the actual retrieval operations has been conducted near the Kennedy Space Center since the spring.

Volcano Aids Studies of Climate

Space agency scientists are studying the plumes emitted from Mount Saint Helens, Washington State, to find out how volcanic eruptions may change the Earth's weather and climate.

Mount Saint Helens eruption data collected for the Aerosol Climate Effects (ACE) program at Ames Research Center is the most complete set of observations ever made of volcanic aerosols in the stratosphere. (Aerosols are fine particles, either solid or liquid, suspended in gas—smoke, fog and mist are common aerosols.) Stratospheric measurements are important because aerosols remain in the stratosphere for months, sometimes years—much longer than they remain in the lower atmosphere.

A NASA-Ames U-2 flew five ACE stratospheric sampling missions of the Mount Saint Helens plume in May and June. Seven experiments aboard the U-2 were designed to observe the atmosphere after the eruptions of May 18, May 25, and June 12.

Preliminary data analysis indicates the volcanic plumes contained a mixture of solid ash particles and sulfuric acid, with proportions varying in different samples.

The amount of sulfuric acid found in the stratosphere was several hundred times greater than the amount found prior to the eruptions. Ash particles as large as 30 microns with a composition similar to ash found on the ground near the volcano, were found during the first flight. On later flights, the largest particles found were about 3 microns.

Large increases in gaseous sulfur dioxide also were detected. Such sulfur-containing gases are sources for additional sulfuric acid particles, which are produced by the action of sunlight on the gas. The sulfur dioxide levels on the first flight were 10 to 1,000 times ambient levels. On the second flight, sulfur dioxide levels were 100 times normal.

Also on the second flight, water vapor abundance within the plume was at least 10 times its normal amount, indicating that a large amount of volcanic water was injected into the stratosphere.

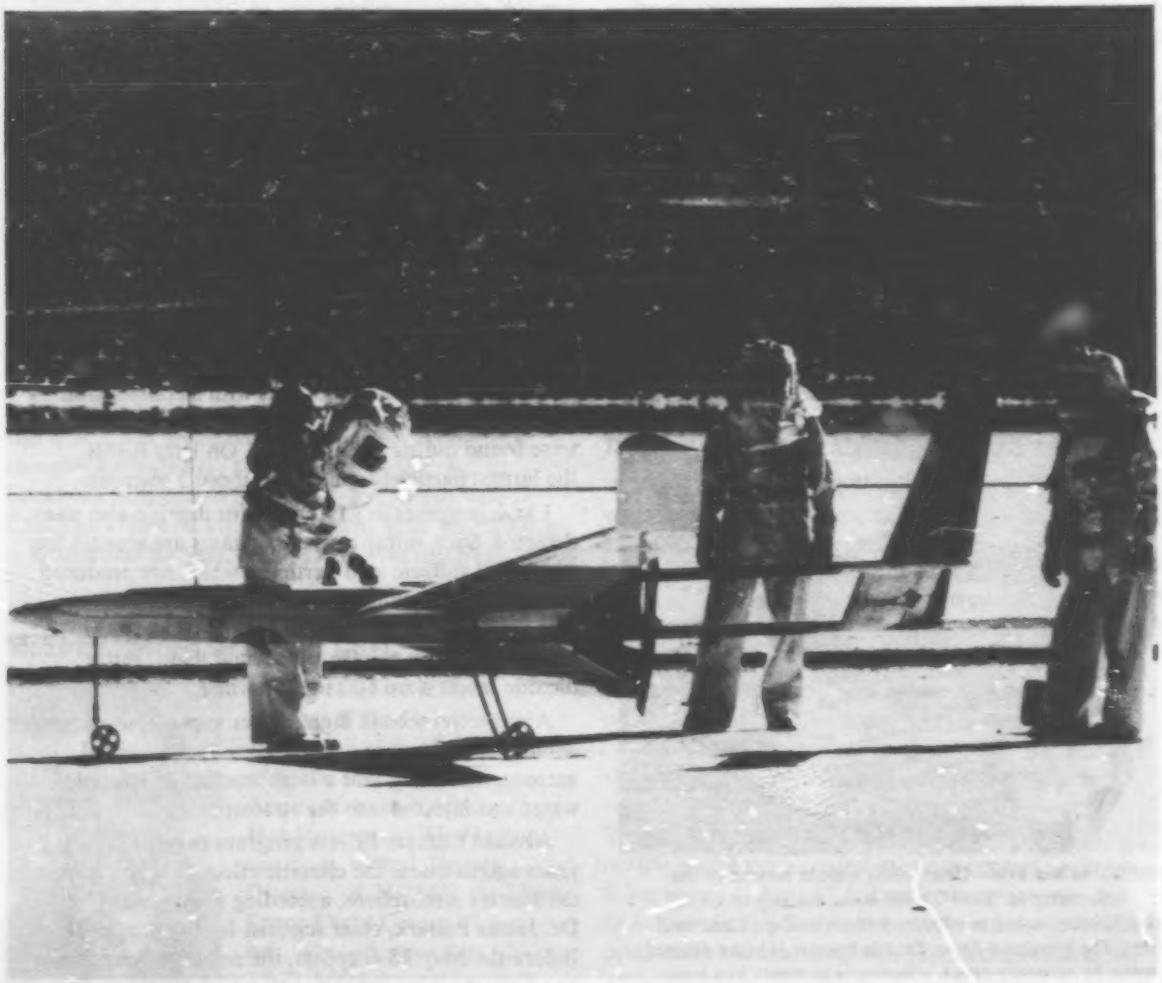
Aerosol Climate Effects program began 1½ years ago to assess the climatic effect of aerosols in the Earth's atmosphere, according to Ames' Dr. James Pollack, chief scientist for the program. Before the May 18 eruption, the program scientists had been studying aerosols using U-2 research aircraft observations in conjunction with NASA satellite measurements of global aerosol number densities. A July 1979 flight over Alaska provided baseline levels for comparison to post-eruption atmospheric conditions.

Over California, the stratosphere at first was relatively unaffected by the May 18 eruption. After debris from that eruption had circled the Earth, it was observed over California between May 29 and June 3 at 13 kilometer (8 millimeter) altitude. Regions above that altitude were clear. The material over California was similar to other samples—ash particles mixed with heavy amounts of sulfuric acid.

In addition to the U-2 sampling missions, NASA Ames sent the U-2 aircraft to photograph Mount Saint Helens on June 19. For one month after the May 18 eruption, Ames personnel watched weather maps for predictions of skies clear enough to allow the U-2 to photograph the volcanic damage from an altitude of 19.8 km.

The U-2 photography has given Washington state agencies the first comprehensive coverage of the damaged area. The U-2 camera has a .61 meter focal length lens, capable of resolving features .61 m to 1.5 m in diameter. Each 228 mm by 457 mm frame represents 6.4 by 13 km on the earth below.

The U-2 data will be used in conjunction with the data acquired by the NASA Stratospheric Aerosal and Gas Experiment (SAGE) satellite for studies aimed at assessing the potential climatic consequences of the Mount Saint Helens eruptions.

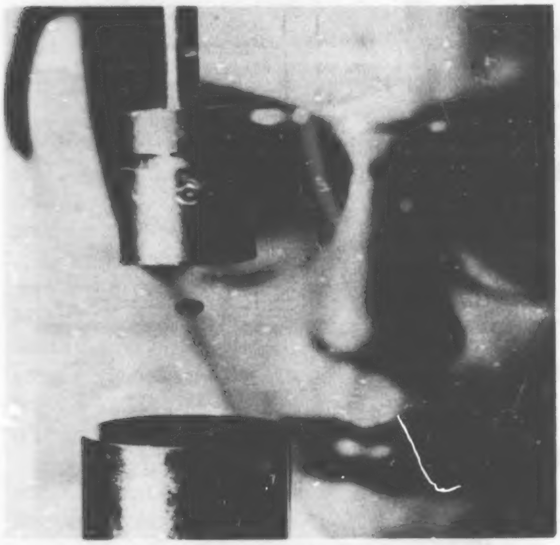


Maintaining the Mini-Sniffer—On the dry lakebed at the Dryden center, technicians in protective clothing service the hydrazine engine on the NASA Mini-Sniffer research vehicle. The tiny engine, developed for use in spacecraft, enables the Mini-Sniffer to fly at extreme altitudes and perform a variety of missions. A craft employing the same technology is under consideration for future exploration of the planet Mars.

Sound Experiments Defy Gravity

Scientists at Marshall Space Flight Center are experimenting with the use of sound waves to make small objects defy gravity. The process is called acoustic levitation, and despite its somewhat supernatural sounding name, it is more than just so much Earth-bound trickery. In fact, some scientists here believe the concept will revolutionize the way in which materials are processed aboard spacecraft, and may ultimately result in improved products for use here on Earth.

"The concept of processing materials in the weightlessness of space is not a new one," explained Richard E. Black, an engineer with Marshall's Materials Processing in Space Project Office. Experiments were conducted aboard Apollo and Skylab missions where glass or metal was melted in a furnace, processed into a new or better substance, and then solidified through cooling. What is new, according to Black, is the technique of "containerless processing," where the material is suspended in an open area within the furnace and processed without touching or being touched by the contaminating walls of the furnace or other container. Therein rests the potential value of acoustic levitation. While a levitator would not be needed in space to counteract gravity, it could be used as a positioning device to control the movement of the free-floating material while it is being processed.



Suspended Water Drop—In a singular close-up picture, engineer Bruce Ross of the Marshall Space Flight Center uses sound wave to suspend a droplet of water in mid-air. It is part of a Marshall experiment with a concept called acoustic levitation, whereby molten materials are suspended during processing in the low gravity environment of space. A levitator could be employed to hold free-floating material in place inside a space furnace without the use of a contaminating container.

The Marshall center is now testing a single axis acoustic levitator, built by Intersonics Inc., of Chicago, for use on the Space Shuttle. The levitator consists of a vibrator which directs high frequency sound waves against a ceramic reflector that bounces them back to create a balanced "energy well" between the source and the reflector. After the furnace is activated, the material sample to be processed is injected into the energy well where it remains suspended while going through the melting, mixing and cooling cycle.

Aboard the Shuttle, the experiment using the levitator will be housed in a 36 cubic inch (540 cc) furnace which will reach a temperature of nearly 3200° F (1600° C). The device will be used in the experimental processing of advanced optical glass. "The potential value of containerless space processing is the ability to produce purer material such as optical glass for telescopes and microscopes," relates Black.

The experiments slated for Shuttle are follow-on projects to acoustic levitation and other containerless processing experiments being conducted on Earth.

Wallops Observes 35th Anniversary

One of the oldest and busiest launch sites in the world, Wallops Flight Center on Wallops Island, Va., has been conducting rocketborne experiments for 35 years. Its first research rocket, a 17-foot Tiamat, was launched before the end of World War II, on July 4, 1945.

Wallops is a space faciilty with a name that dates back 300 years. Local Indians on the Eastern Shore of Virginia had called the sandy island Keeckotank, or Occocomoson. Then, in the 17th century, one John Wallop was appointed Deputy Surveyor of the colony and was granted a patent in 1672. Fortunately, from a standpoint of paperwork, the Wallop name prevailed.

Since its origin as a rocket range, Wallops has launched approximately 12,000 research vehicles consisting of from one to seven rocket stages, in the quest for aeronautical research information on the flight characteristics of airplanes and to increase the Nation's knowledge of the upper atmosphere and the near space environment. Vehicles have flown as high as 19,000 miles above the Atlantic Ocean and at speeds in excess of 38,000 miles an hour. Nineteen satellites have orbited from the Island.

In the early years, research at Wallops was concentrated on obtaining aerodynamic data at transonic and low supersonic speeds, as part of the effort to penetrate the sound barrier of flight. Today rocket vehicles launched from Wallops carry scientific experiments to gather information about the atmosphere and space, aeronautics and the characteristics of aerospace flight, and to develop concepts and instrumentation that are candidates for future space flight.

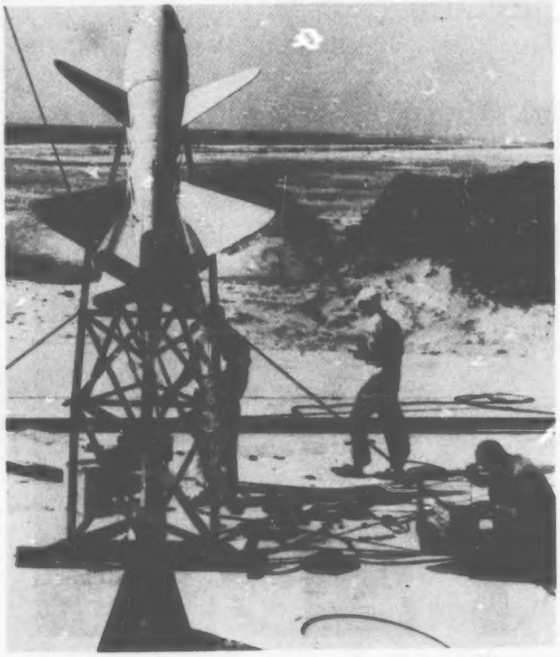
In 1945, NASA's predecessor agency, the National Advisory Committee for Aeronautics (NACA), established a launch site on Wallops Island under the direction of the Langley Research Center. This site was designated the Pilotless Aircraft Research Station (PARS) and assigned the mission of conducting aeronautical research to supplement wind tunnel and laboratory investigations. When Congress established the National Aeronautics and Space Administration (NASA) in 1958 and absorbed Langley and other NACA field centers and research facilities, the PARS became a separate facility—Wallops Station—operating directly under NASA Headquarters in Washington, D.C. It was renamed Wallops Flight Center in 1974.

It was from Wallops that Sam and Miss Sam, two rhesus monkeys, rode into space to test the Mercury spacecraft. These two space pioneers, aboard a Little Joe booster, checked out the recovery and life-support systems before Astronaut Alan Shepard took his famous ride during Project Mercury. The first test launch of the Echo balloon satellite was also performed here. The sodium and barium vapor cloud experiments which measure the Earth's magnetic fields and winds aloft have created spectacular "space shows" for East Coast residents.

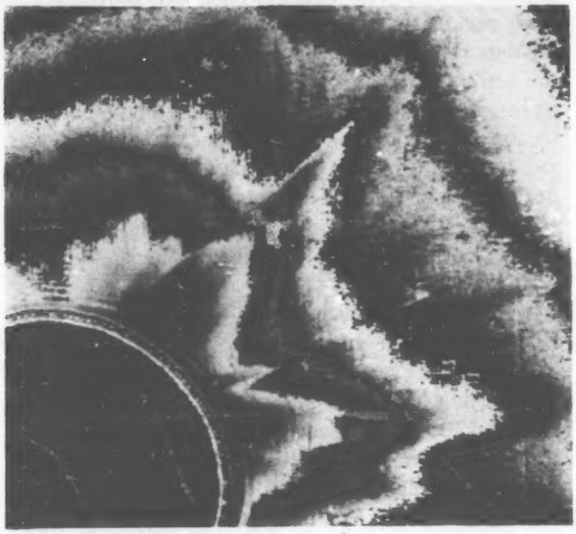
Aeronautical research at Wallosp covers a wide range: helicopter and aircraft noise abatement projects; slow speed landing techniques for jet aircraft; anti-skid tests on grooved runways; V/STOL terminal area research; collision avoidance program; laser and radar tracking of aircraft spin characteristics, cross-wind landings, pilot performance, and procedures and aids at uncontrolled airports and airspace.

Today a substantial part of the center's manpower is still devoted to the support and management of the national sounding rocket program. Sounding rockets are used to fill the gap between the maximum altitude for balloons and the minimum altitude for satellites. Experiments flown on sounding rockets provide a variety of information, including high altitude wind shear and velocity, density and temperature of particles in the upper atmosphere, properties and changes in the ionosphere, measurements of the brightness of stars and natural radiation surrounding the Earth, characteristics of the ionization phenomena as space vehicles reenter the atmosphere, and many other phenomena of Earth's environment in space. Ocean physics and dynamics are also under investigation at this versatile facility.

The center has strong international connections, training and advising foreign personnel in launching experiments and range operations. Naturally, Wallops has an important role in the Space Shuttle project, especially in the areas of tracking and command. About half of the 400 people employed at Wallops Island are engineers and technicians. They are advancing aerospace and the NASA programs from a once-remote part of historic Virginia.



Independence Day, 1945—On the beach at Wallops Island, Virginia, the first experimental vehicle of a new NACA launch site is ready for firing. The rocket is called Tiamat and the date is July 4, toward the end of World War II. This was part of a project to develop the first Air Force air-to-air missile. With the advent of NASA in 1958, Wallops Station became a separate facility and the center is celebrating its 35th anniversary.



Solar Flare Imagery—Data supplied by the Solar Maximum Mission satellite provided this splashy image of the solar corona. The picture was taken by an instrument called the coronograph/polarimeter, which studies the Sun's outside "envelope", its evolution and the transient activity within. The new data on solar flares clearly shows a prominent line extending from the Sun, a type of flare variously known as a coronal spike, or streamer. These extensions can reach one-tenth the distance to the Earth.

New Data on Solar Flares

An intensive worldwide effort, planned for more than two years, has resulted in an accumulation of scientific data that solar scientists believe will provide them with the clearest knowledge of solar flares ever produced.

The effort, known as a flare buildup study, involved experiments aboard NASA's orbiting Solar Maximum Mission spacecraft and a network of the world's most highly sophisticated and powerful ground observatories. It was coordinated by Dr. Paul Simon of the Observatoire de Paris, France, as part of the International Solar Maximum Year.

Purpose of the study was to obtain as many scientific measurements from as many different sources as possible during a six-week period in 1980, the year the Sun is at the peak of its 11-year cycle of activity. The dates were established two years ago, when the scientific community gambled that the second two weeks of May and the month of June would be an active period on the Sun. During the early stages of the study, the scientists were able to make some significant observations.

Then, on June 24, observatories in 18 nations and all flare instruments aboard the spacecraft—based on predictions of worldwide forecast services—focused on an active region of the Sun identified as Region 2522. On June 28 and June 29, the Sun produced two major flares out of Region 2522.

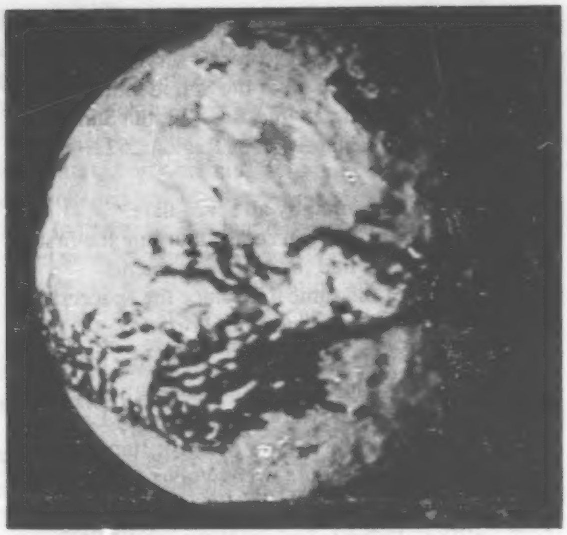
Significantly:

- They were captured by all seven flare instruments aboard the spacecraft, marking the first time all instruments had made measurements simultaneously of the same flare since the spacecraft was put into a 575-kilometer-high orbit.
- Leading world observatories, including the Solar Radio Observatory in Culgoora, Australia; Sacramento Peak Observatory and the Very Large Array Radio Telescope in New Mexico; Itapetinza Observatory in Brazil; the Owens Valley Radio Interferometer in California; and the Mauna Loa Observatory in Hawaii, also obtained information from the flares. The flares occurred during daylight hours for the observatories in the United States, South America and Australia.
- The observation was the first from which scientists can trace material ejected from a flare from the Sun's edge into the outer solar atmosphere. Through the collaborative use of the instruments on the spacecraft with the Culgoora radioheliograph in Australia, the data are expected to provide new understanding of the intensity of the magnetic field and the electron density in the matter blown from the flare.
- The two flares were what scientists call homologous flares. They were nearly identical in structure, position and character. Explanations for the occurrence vary from sheer accident to the theory that the magnetic field reconfigures itself after one flare has fired to the same configuration it had prior to the flare, with the second instability being almost identical with the first. If the similarities are not accidental, homologous flares provide important clues concerning the physical mechanism operating at the surface of the Sun to control the magnetic structure in an active region.

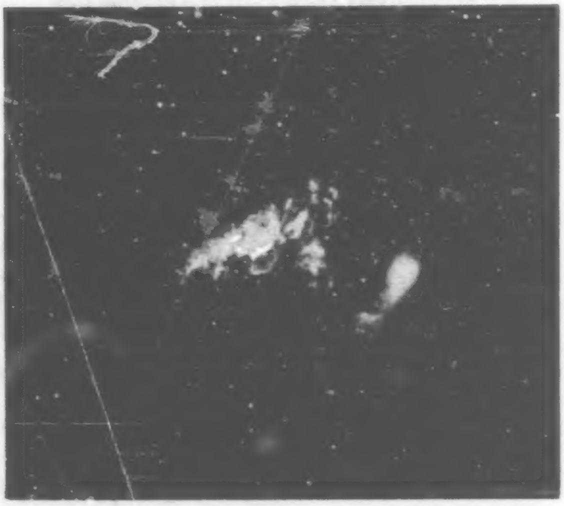
The degree of uniformity from flare to flare will prove to be very significant in resolving the puzzle of homologous flares, and the comprehensive coverage by the spacecraft and the ground observatories should allow scientists to determine if homologous flares are accidental or not.

The significant contributions from other observations include:

- Very Large Array—This is a complex radio telescope for probing the precise location of radio



Venus Surface Exposed—The extent of the highland area, Aphrodite, is shown in a global view of Venus, stripped of its perpetual cloud cover by the radar altimeter of the Pioneer Venus spaceraft. The point of observation is over the Equator at 90 degrees East longitude. Artificial illumination was introduced in the picture to highlight the surface relief representation. The data was acquired by the NASA Ames Pioneer Venus project, involving a number of scientists in and outside of the space agency.



Swan Nebula in Infrared—Using data obtained from the NASA Ames Kuiper Airborne Observatory, scientists at Caltech created this image of the Swan Nebula (M17) as it would appear through a large telescope sensitive to infrared. The region is located in the southern sky in the constellation Sagitarius and contains a cloud of ionized, interstallar gas excited by recently formed stars. Astronomers call this type of cloud an HII region and the M17 HII region is bounded on the southeast by a molecular mass.

sources in the universe. For several days during the study period, the telescope was dedicated to observing the flare radio emissions and their locations near the Sun's surface. A newly-operational telescope, its measurements provide information on the precise location where electrons, accelerated in the flare, emit radio waves. Coupling these data with location information of similar electrons obtained by the spacecraft's hard X-ray imaging spectrometer and with spectral information obtained by the spacecraft's hard X-ray burst spectrometer and gamma ray experiment, the telescope obtained the most detailed observations ever on the release of energy in a flare during its earliest stages.

- Sacramento Peak Observatory—Observations from this location provide information on the transport of the flare's intense heat to the colder parts of the solar atmosphere underlying the site of the flare explosion. These measurements provide a clearer understanding of the means by which energy is propagated away from the flare.
- Culgoora Radioheliograph—This instrument, located in Australia, provides unique information on the interaction of energetic electrons with the magnetic field trapped in the ejected mass and provides measurements of the velocity of the ejection as it exits the solar atmosphere. It also gives information on shock fronts generated by the flare ignition.

Observations from the optical telescope at Mauna Loa, Hawaii, combined with data acquired by the spacecraft's coronograph/polarimeter, provide detailed pictures of mass acceleration in a flare, the propagation of that mass outward into interplanetary space.

The radiation of energy from intensely hot, 22 million degrees Celsius, gas formed by the flare was observed in detail by the spacecraft's soft X-ray polychromator, another instrument assisting the scientists in obtaining a total picture of flare activity.

Highest-Ever Cash Award to Lewis Inventor

Dr. Henry G. Kosmahl, a satellite communications specialist at NASA Lewis Research Center, has received the highest monetary award ever given by Lewis for an invention. He is the recipient of a check for $15,000 for taking the lead role in development of what is considered the world's most powerful and efficient amplifier for audio and video signals from space.

Dr. Kosmahl's invention is known as a depressed

Handshake and $15,000—Dr. John M. Klineberg, Deputy Director of LRC, left, congratulates electronics specialist Henry C. Kosmahl with a check for the highest cash amount Lewis has awarded for an invention. Kosmahl's traveling wave tube provides 10 to 50 times the power of conventional transmitters for relaying broadcast signals via communications satellite.

collector tube. As part of a traveling wave tube in space, it provides the tube with 10 to 50 times the transmitting power of a conventional traveling wave tube such as used in commercial satellite communications today.

The depressed collector tube operates by retrieving energetic electrons which would otherwise give up their energy and returning them to the power source for reuse in transmitting signals from space. An analogy might be droplets of water in a fountain being captured on their way up while they still have energy or force. If you allow the droplets to reach the peak of their upward thrust, at that point all their energy will have been spent.

Currently, the U.S. Department of Defense is using the Kosmahl tube as part of its electronic warfare arsenal. The tube is also expected to be used on future commercial communications satellites and in UHF-TV transmitters throughout the U.S. to reduce electric power consumption. In the latter case, a power savings of approximately one billion kilowatthours per year is expected.

German-born, Dr. Kosmahl holds ten U.S. patents, six foreign patents and has three patents pending. In 1974 NASA awarded him its highest science medal for developing the depressed collector tube. He is a Fellow of the Institute of Electrical and Electronic Engineers, and is listed in Who's Who in Science and Technology as well as in American Men of Science.

Contractor News

Martin Marietta Aerospace Corp., Denver Div., has been awarded a $230 million cost-plus-award-fee contract by the Marshall Space Flight Center for the initial full-scale production phase of Space Shuttle external tanks. The external tanks, which carry propellant for the Orbiter's main engines, are the only part of the Shuttle that is not recovered for reuse. This new production contract provides flight tank production to support Shuttle operational missions, covers delivery of seven external tanks, and provides long lead-time procurement for components and subassemblies for five additional tanks and raw materials for 24 additional tanks.

General Electric Co., Space Div., Valley Forge, Pa.; **Lockheed Missiles and Space Co.,** Inc., Sunnyvale, Calif.; **RCA Astro-Electronics,** Government Systems Div., Princeton, N.J.; and **Rockwell International,** Satellite Systems Div., Seal Beach, Calif., have been selected for negotiation of nine-month $750,000 fixed-price alternate-system definition studies for the National Oceanic Satellite System (NOSS). These Phase I studies will define the system to be developed beginning in FY 81, subject to Congressional approval of the program. The studies will include flight segments, ground segments, and orbit operations.

Thiokol Corporation, Huntsville, Ala., has received an $8.5 million letter contract for Castor IV motors for use on the Delta launch vehicle. The contract is expected to become part of a firm fixed-price supplemental agreement to an existing negotiation for 63 of the motors at an estimated cost of $20.9 million. Castor motors are strapped on the Delta first stage for liftoff thrust augmentation. The program is managed by the Office of Space Transportation Operations at NASA Headquarters.

Boeing Aerospace Co., Seattle, Wash., has been selected to assist NASA in a study of future space transportation needs under a contract valued at about $200,000. The selection was made by the Marshall Space Flight Center and the study will be conducted over the next 12 months. In the post-1990 time period, with the Shuttle-based Space Transportation System fully operational, user requirements may outgrow the capacity of presently planned orbital transfer vehicles to move large structures and satellites from low Earth orbit up to geostationary orbit 37,000 kilometers (23,000 miles) out in space, and to carry scientific probes to other planets. In preliminary planning for this future need, the Marshall Center has studied several possible advanced propulsion systems. These systems include, among others, rocket engines heated by solar concentrators and lasers, along with advanced electric propulsion. These and other systems studies are now ready for analysis and comparison to determine which concepts are the most likely candidates for further study and possible development to meet space transportation needs 10 or 20 years from now.

General Electric Company, Philadelphia, and **Ford Aerospace & Communications Corporation,** Palo Alto, Calif., have been awarded parallel two-year contracts by the Lewis Research Center for the design, development and delivery of a switching system for an advanced commercial communications satellite. The $1,462,212 contract to General Electric and the $941,329 contract to Ford are cost-plus-fixed-fee. Under each of the contracts, companies will design and build an on-board satellite switching system that will allow multiple signals from the ground to be received and then routed by the satellite to multiple designated ground stations. The system will allow for a maximum of 20 input and 20 output signals.

Aerospace Services Division of Pan American World Airways, Inc., Cocoa Beach, Fla., has received a one-year extension of its contract to supply medical services to the Kennedy Space Center and Cape Canaveral Air Force Station. The over $2 million award covers the period from July 1, 1980, to June 30, 1981, and brings the cumulative value of the contract since 1977 to $8 million. The services are provided by physicians, medical technicians and nurses in facilities at KSC and the Air Station.

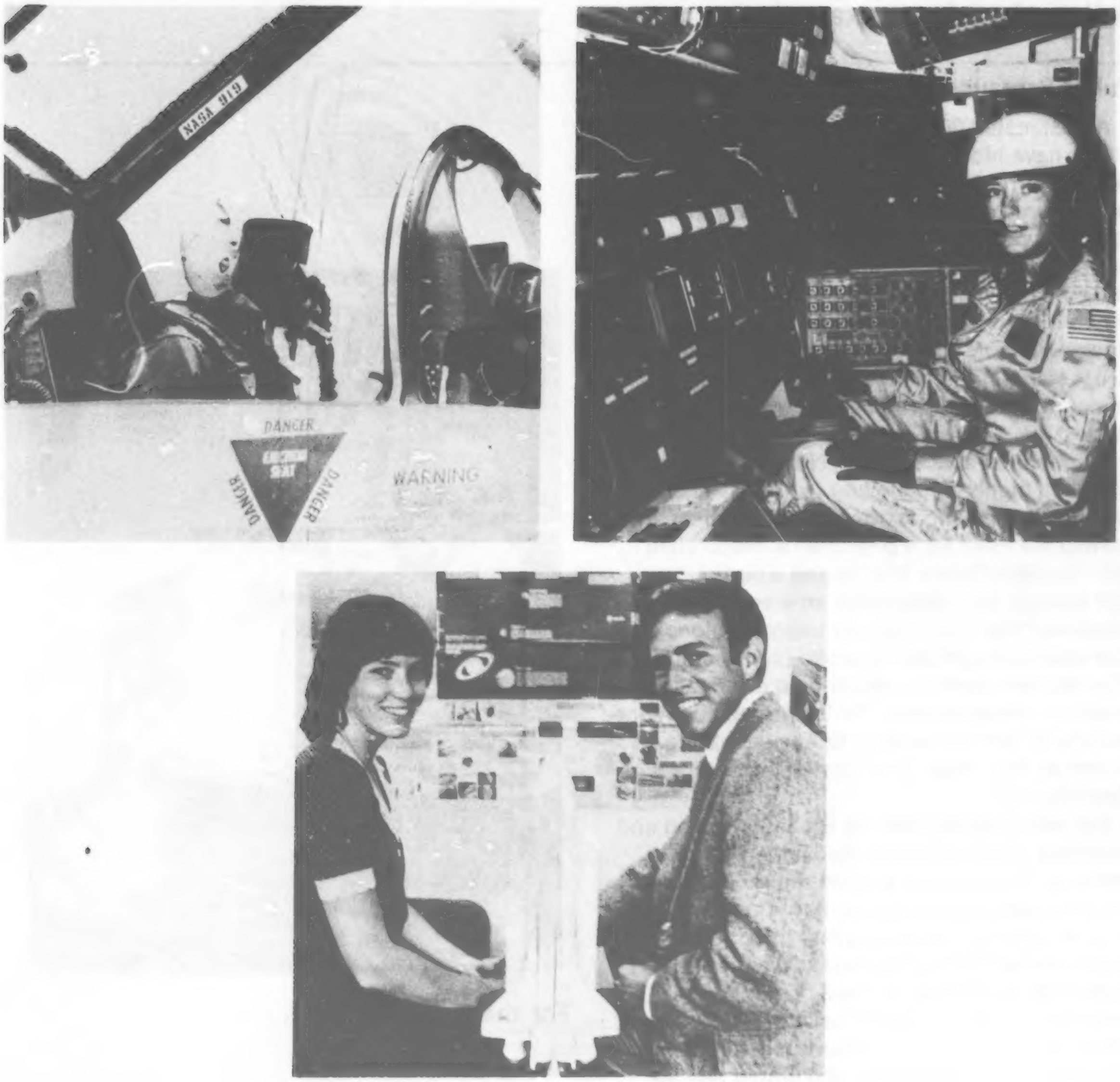
Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Madeline S. Toy, Roger S. Stringham Science Applications Inc., La Jolla, Calif.	Process for producing flame resistant polyamides and products thereby produced	4,203,723	JSC
W. Preston Dill, Eldon L. Jeffers Rueben E. Taylor, Boeing Aerospace Company, Houston, Tex.	Method and automated apparatus for detecting coliform organisms	4,204,037	JSC
Reinhard Beer, Caltech/JPL	Cooled echelle grating spectrometer	4,205,229	NRO/JPL
Jack S. Margolis, Daniel J. McCleese Michael S. Shumate, Clay H. Seaman, Caltech/JPL	Method and apparatus for doppler frequency modulation of radiation	4,201,468	NRO/JPL
Cyril Feldstein, Gilbert W. Lewis Virgil H. Culler, Caltech/JPL	Simultaneous muscle force and displacement transducer	4,204,544	NRO/JPL

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January 17	Atlas Centaur	ESMC	DOD Navy. Reimbursable.
SMM-A	February 14	Delta	ESMC	NASA. Scientific Solar Maximum Mission.
NOAA-B	May 29	Atlas-F	WSMC	NOAA Weather. Reimbursable. Launch vehicle failed.
GOES-D	September 9	Delta	ESMC	NOAA Weather. Reimbursable.
SBS-A	October	Delta	ESMC	Satellite business systems. Reimbursable.
FLTSATCOM-D	October	Atlas Centaur	ESMC	DOD Navy. Reimbursable.
Navy 20	November	Scout	WSMC	DOD Transit. Reimbursable.
Intelsat V-A	November	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.



Two for the Shuttle—Astronaut Candidate Dr. William Fisher (upper left) positions himself in the rear seat of a T-38 jet trainer for a familiarization flight at Johnson Space Center. His wife, Astronaut Dr. Anna Fisher (upper right) tries out the pilot controls in the Shuttle Orbiter aeroflight simulator at JSC. William Fisher was among the 19 new astronaut candidates selected this year while Anna has been in the astronaut training program since 1978. He is 34, she is 30, and both are physicians sharing the specialty of emergency medicine. They are training as mission specialists in the Shuttle program. Although their first flights are years in the future, the Fishers represent another NASA milestone—the first Space Age couple.

Another Dividend from Air and Space

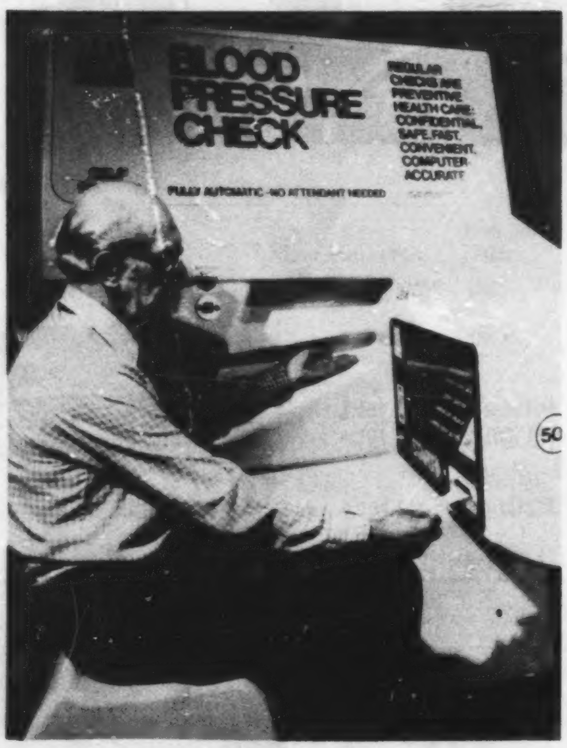
Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Public Pressure Checker

An estimated 30 million people in the United States have blood pressure or hypertension in some form. But a great many of the victims are unaware of their condition because in the case of hypertension, it displays no symptoms in the initial stages. Now, simply-operated blood pressure checking devices are widely located in public places throughout the nation. The machine pictured is called Medimax 30 and is a direct spinoff from NASA technology developed to monitor the health signs of astronauts in space.

For manned space flights, NASA wanted a compact, highly-reliable and extremely accurate method of checking astronaut's blood pressure without the need for a physician's interpretive skill. Johnson Space Center and a contractor, Technology, Inc., developed an electronic sound processor that automatically analyzes blood flow sounds to get both systolic (contracting arteries) and diastolic (expanding arteries) blood pressure measurements. NASA granted a patent license for this technology to Advanced Life Sciences, Inc., New York City, manufacturers of Medimax 30.*

The self-checking device is coin operated and produces blood pressure readings in only 30 seconds; it provides a printed record as well. The process is extremely simple. The user puts an arm in the self-adjusting cuff and the rest is quick and automatic. Medimax 30 allows the hypertension sufferer to keep ongoing blood pressure records between visits to the doctor's office. It also affords an opportunity for early detection of the disease by the untold number of people who are not aware they have a problem.


BLOOD PRESSURE CHECK
REGULAR CHECKS ARE PREVENTIVE HEALTH CARE: CONFIDENTIAL, SAFE, FAST, CONVENIENT, COMPUTER-ACCURATE
FULLY AUTOMATIC - NO ATTENDANT NEEDED

For the benefit of all . . .

NASA
National Aeronautics and Space Administration

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of such technology.

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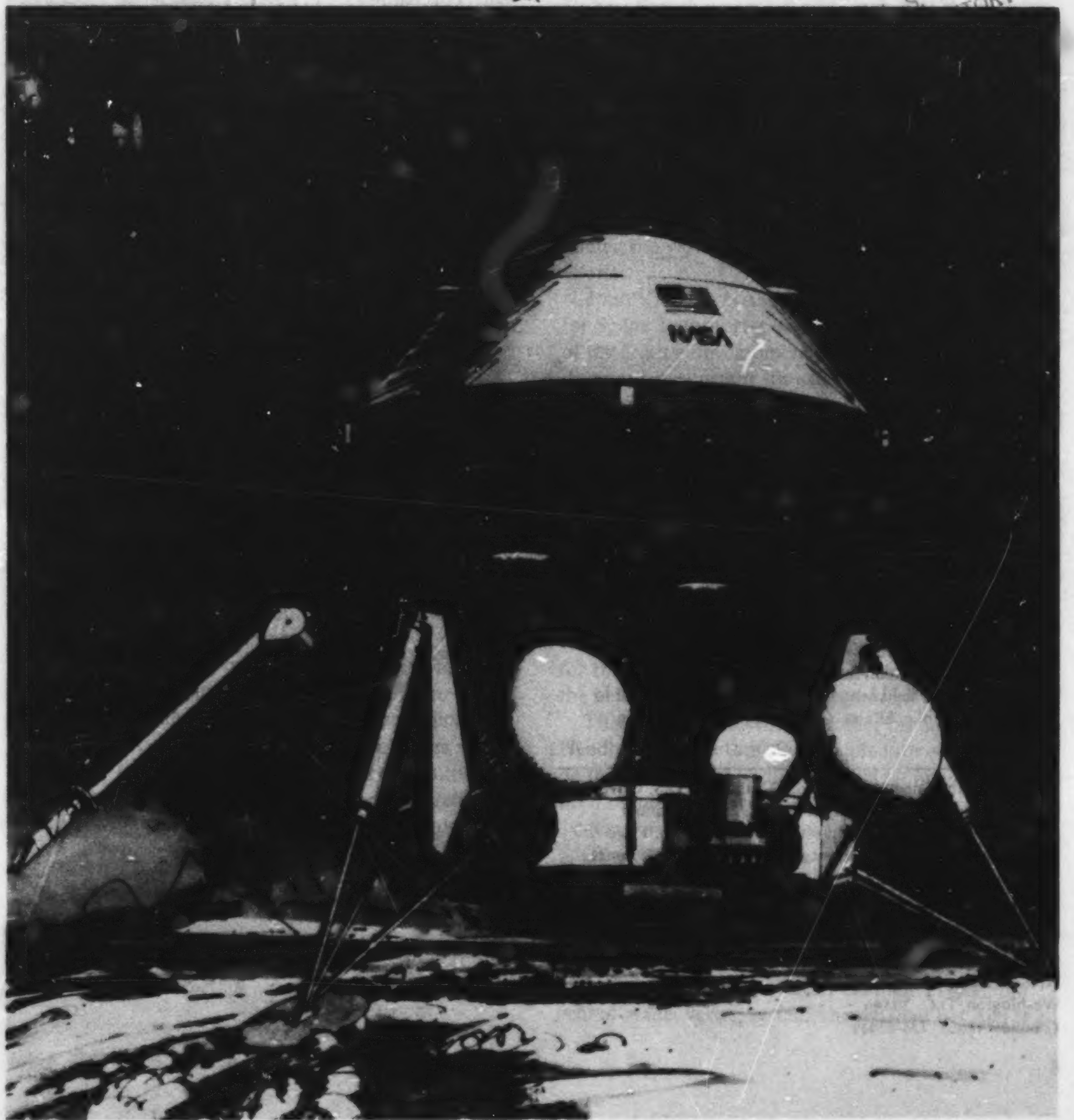

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COVER

A Piece of Mars—The painting shows a proposed Mars Ascent Vehicle as it lifts off the surface of the Red Planet to deliver a soil sample to Earth for analysis. A mission study, performed for NASA by the Jet Propulsion Laboratory, was based on a rendezvous in Mars orbit, similar to the lunar orbit arrangement used by Apollo. A lander vehicle would touch down and pick up a sample of soil. The lander base would be left behind. The return vehicle, a three-stage craft, would fly to a 500-kilometer orbit around the planet. In the painting, at above left, are the carrier orbiter and a rendezvous/return orbiter. After the surface mission is complete, the rendezvous/return vehicle would remove the soil sample from the ascent craft and bring it back to Earth.

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Letter from Washington

Dear Colleagues:

As everyone at NASA knows, our agency is currently involved in a concerted drive to complete the development of the Shuttle and to launch Columbia on the first orbital test flight in March. This effort necessarily has our highest priority, since a successful, operational Shuttle is central to our entire national effort in space through the remainder of the century. But in the concentration of our attention, time and labor on the Shuttle program, it is important for us to remember, first, that we do other vitally important things—we are not a one-shot, single program agency—and, second, that the Shuttle is not an end in itself but an advanced tool which will permit us to do better what we are now doing in space and which will enable us to do things there that we cannot do today.

One of the things Shuttle will enable us to do better is space science, an area in which we already hold uncontentested and recognized world leadership. Galileo, VOIR, and Space Telescope, to name only three programs, all depend on the Shuttle for eventual success. We can find pride and encouragement in the fact that the fiscal year which is just beginning will see not only our first manned launch since 1975, but the two dramatically important Voyager encounters with Saturn as well, one only a month away, the other in late summer.

Thus, while it is important that we achieve for our our country the ability to fly off and back on to our planet at will, with all the benefits that capability will bring, it is equally important that we utilize that ability to continue and expand our efforts to probe the solar system and the universe in search of the knowledge mankind has always needed and on which his long-term future may well depend.

Sincerely,

Robert A. Frosch

Briefing Series on Space Transportation

NASA began a comprehensive series of media briefings on the development and utilization of the nation's Space Transportation System on Sept. 10 at NASA Headquarters in Washington. The series will continue throughout the initial flight testing of Columbia, the first Space Shuttle in the fleet of new Earth-orbiting vehicles the United States will fly to and from space in the 1980's.

The subject of the first briefing was "Technological Innovation in the Design and Development of the Space Shuttle." NASA Administrator Dr. Robert Frosch presented an overview of the technological innovation required in order to design the country's first generation of reusable space vehicles. He identified and described the major advances required by the transition from the country's expendable Saturn launch vehicle capability, developed for the Apollo program, to the first generation of reuseable Space Shuttle vehicles, and reviewed how NASA and its contractors have organized and conducted the various activities associated with those efforts.

John Yardley, NASA's Associate Administrator for Space Transportation Systems, reviewed the status of the Shuttle development program in general; discussed the current status of significant technological requirements; and outlined the schedule NASA must achieve in order to meet the planned launch date for the Columbia's first flight in March 1981.

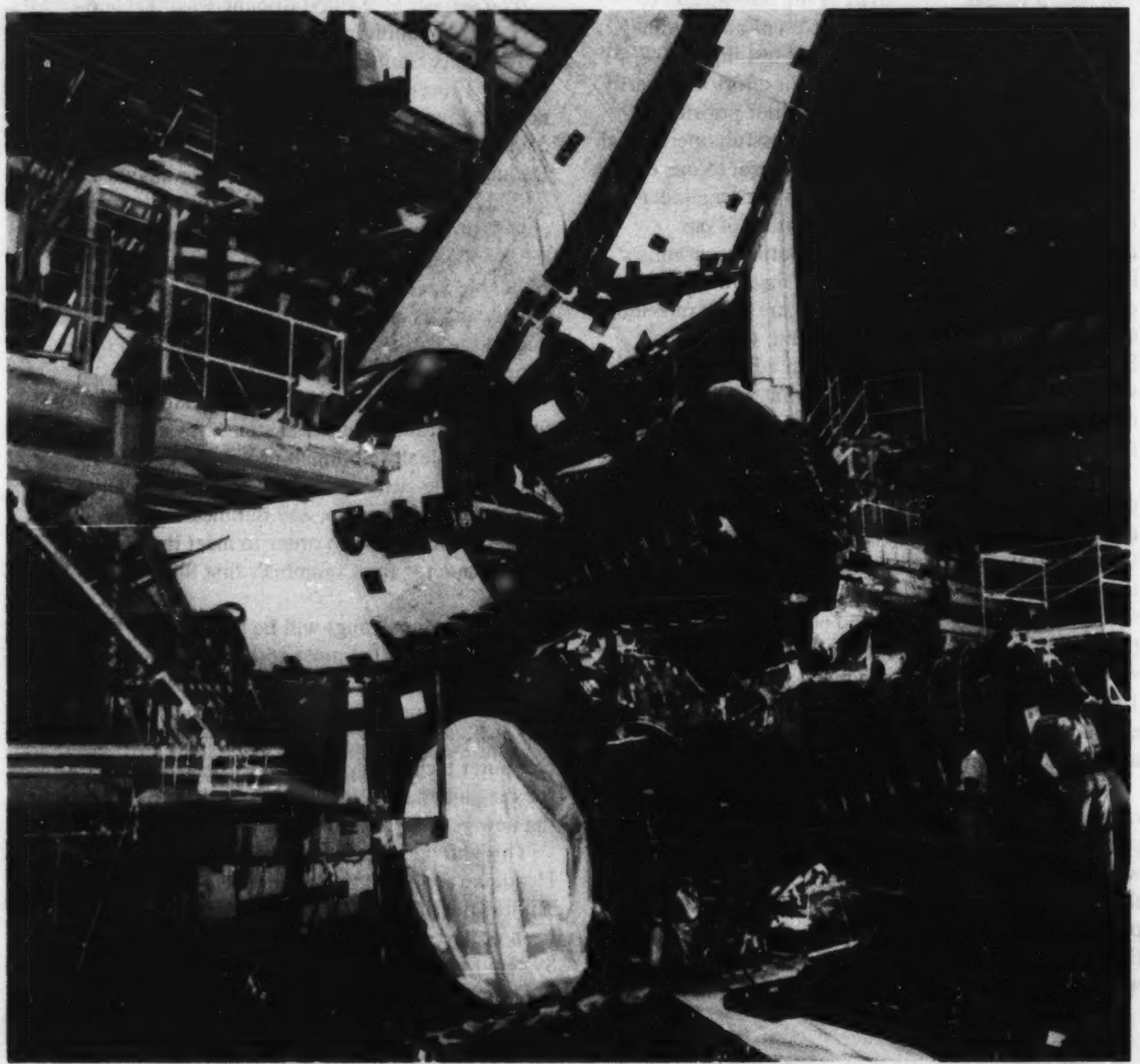
Subsequent briefings will be held at two- to three-week intervals at the most appropriate location among the various NASA centers involved in the development of the Space Transportation System. Officials will describe the use of on-board and ground-based computer technology and data processing required for the guidance, navigation and orbital activities of the new generation of piloted spacecraft.

This will be followed by another briefing at NASA Headquarters, tentatively scheduled for early October, on the government/industry partnership which has been required to develop a Space Transportation System for the United States.

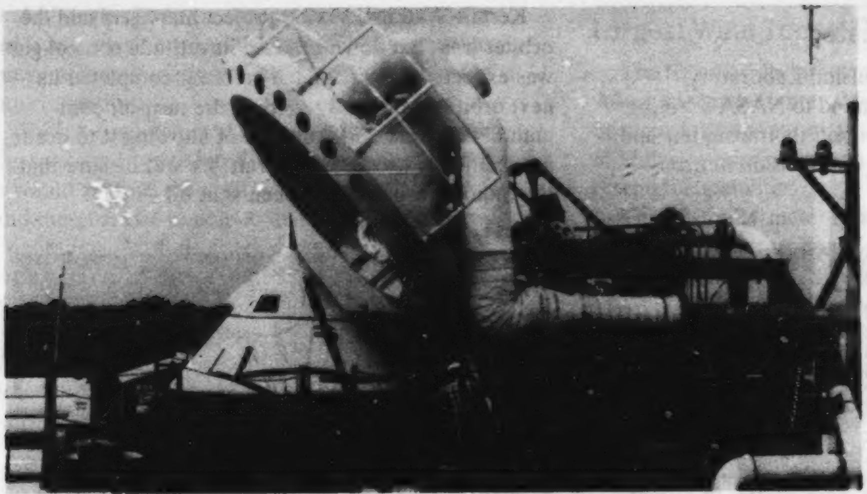
Other subjects during the next six months will include plans for the utilization of the Space Transportation System as a new national resource by NASA, other government agencies and private industry; descriptions of the various components of the system such as the orbiter, the main engine, the orbital maneuvering system, the payload bay and the thermal protection system; detailed discussion of crew training and crew activities in flight; launch and landing operations; flight operations; flight readiness activities and mission verification testing; and the flight plan for STS-1, the first orbital flight test.

During these briefings, news centers at Kennedy Space Center, Fla.; Johnson Space Center; Marshall Space Flight Center, Huntsville, Ala.; and NASA Headquarters are linked by audio circuits so that media representatives may listen to the discussion and question the participants from any of those locations.

All of the sessions are on the record, for attribution. Transcripts will be published to provide a printed collection of reference material for media representatives who cover Space Transportation System activities. And a written status report on the progress of technological developments and other flight preparations is available at each briefing.



Shuttle's Power Plant—With Engine #1 already installed, an engineering crew at the Kennedy Space Center prepares to guide Engine #3 into the aft end of the Shuttle orbiter Columbia. The three main engines that will power the Columbia into space on its maiden voyage have been reinstalled following modifications and successful recertification firings at the NSTL facility in Mississippi. The engines were pulled earlier this year for modifications of the high pressure turbopumps, valves and nozzles.

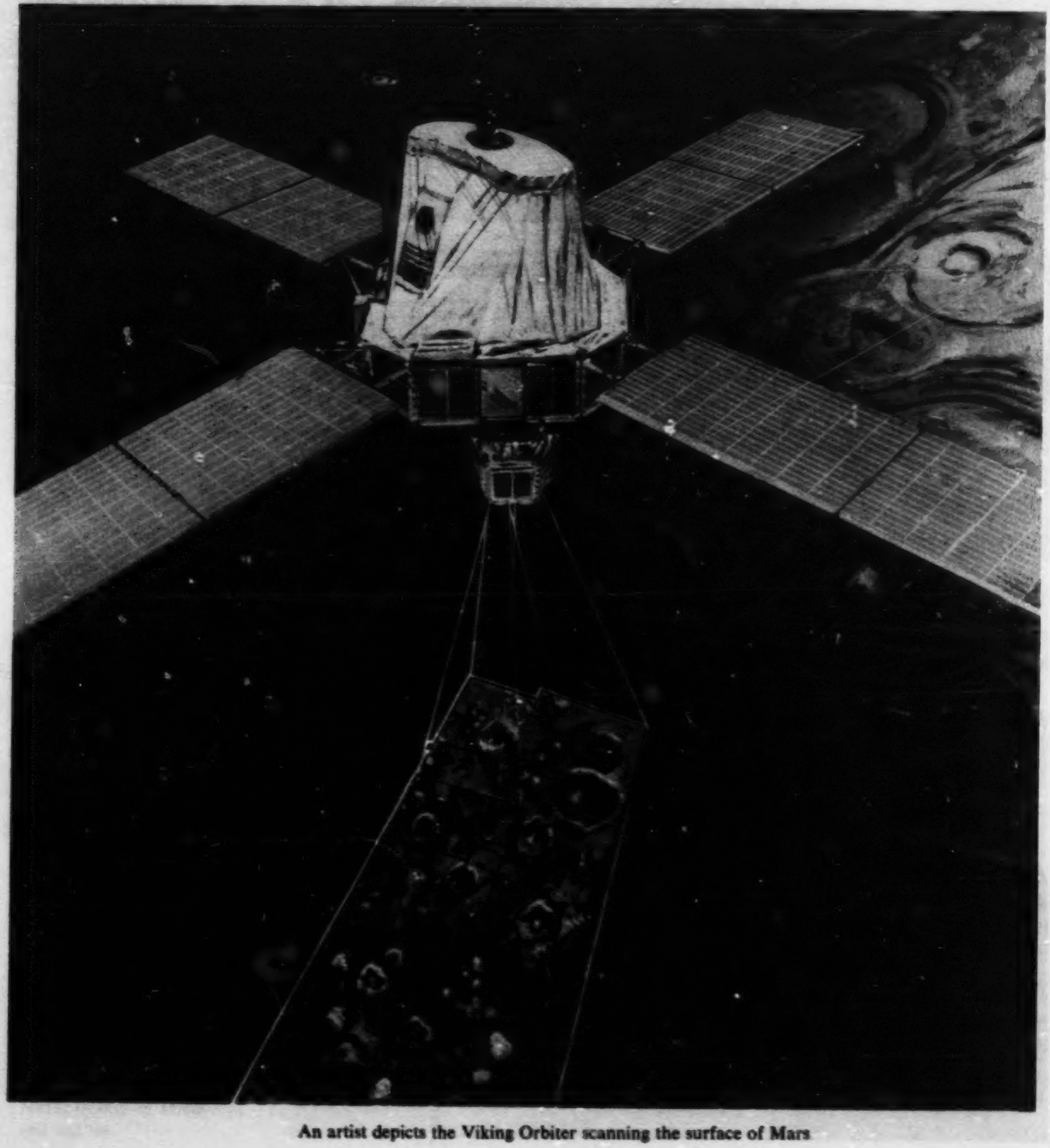


Aiming for March—With the Shuttle launch date confirmed, preparations intensify at the Kennedy center. At KSC's Launch Equipment Test Facility (upper), technicians perform fit checks on a full scale mockup of the so-called "beanie cap". The device will remove cold oxygen vapors from the external tank top shortly before launch. In the Vehicle Assembly Building (center), an engineer is lowered into the aperture of a solid rocket booster forward segment to inspect for cracks and other defects. At a small pond south of the Shuttle Landing Faciliy (lower), personnel practice emergency water rescue operations using a mannequin to simulate an astronaut crewmember.

Viking Orbiter 1 Terminated

Engineers at the Jet Propulsion Laboratory, Pasadena, sent a radio command to NASA's Viking Orbiter 1 in August, switching off its transmitter and ending the spacecraft's four-year mission in orbit around Mars.

Kermit Watkins, Viking project manager, said the orbiter was shut down because its attitude control gas was expected to be depleted before it completed its next orbit of Mars. "By sending the turn-off command," Watkins said, "instead of allowing it to occur automatically on the space craft, we will be sure that the radio transmitter has been shut off."



An artist depicts the Viking Orbiter scanning the surface of Mars

Although silent, the spacecraft will continue to orbit Mars well beyond the turn of the century to prevent contamination of the planet's surface for future missions.

Viking engineers had been carefully monitoring the spacecraft since late July in the expectation that it would soon use the last of its attitude control gas and therefore be unable to maintain the correct orientation. Attitude control gas keeps the spacecraft's radio antenna pointed to Earth and the power-producting solar panels aimed at the Sun.

Viking 1 was launched on Aug. 20, 1975, from Cape Canaveral, Fla., and achieved Mars orbit on June 19, 1976. It had been operating continuously since then.

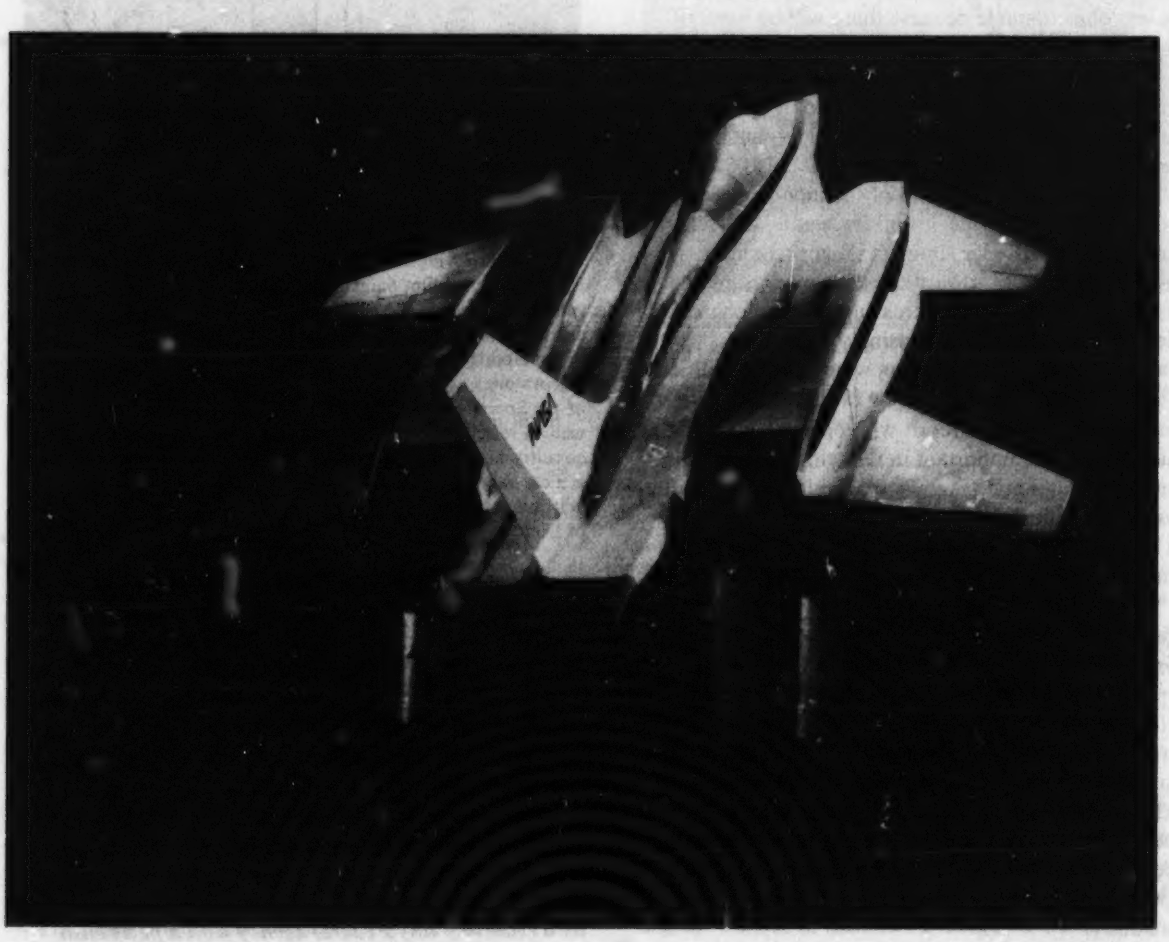
Viking Lander 1 continues to collect scientific information on the surface of Mars. It is programmed to transmit to Earth, weekly when interrogated, until December 1994.

Largest Wind Tunnel Closed

The free world's largest wind tunnel, at NASA's Ames Research Center, Mountain View, Calif., will be closed for about one year for an $85-million modification project which will greatly increase its research capabilities.

The 12-by-24-meter tunnel has been in almost continuous use since its completion in 1944 and has made important contributions to the development of vertical takeoff and landing concepts, powered lift concepts, rotary wing concepts and many military and civil conventional takeoff and landing aircraft.

The major modification is the addition of a 183-m long structure extending northwest from the west side of the present structure. The new structure, or leg, will house a new larger test section—24 by 27 m —and will have a bell-shaped air intake 110 m wide and 40 m high.



Scale model of a supersonic fighter in the huge Ames wind tunnel

The six 6,000-horsepower electric motors which have powered the wind tunnel since 1944 will also be replaced, with modern 22,500-hp units, raising the maximum wind tunnel drive power from the present 36,000 hp to 135,000 hp.

The additional power will increase the top speed available in the present test section from 370 kilometers per hour to 555 km/hr, and will provide test speeds in the new larger test section of up to 185 km/hr. The present fixed-pitch fans will be replaced with slower turning variable-pitch fans.

A major effort in the design of the modification has been to keep the amount of noise generated by the facility to an absolute minimum. Special low-speed fans will be employed and extensive acoustic treatment is planned at both the intake and exit of the new test leg. Engineers expect that the modified facility will generate no more noise than is presently generated, and that the noise which is generated will be less objectionable because there will be no continuous tones.

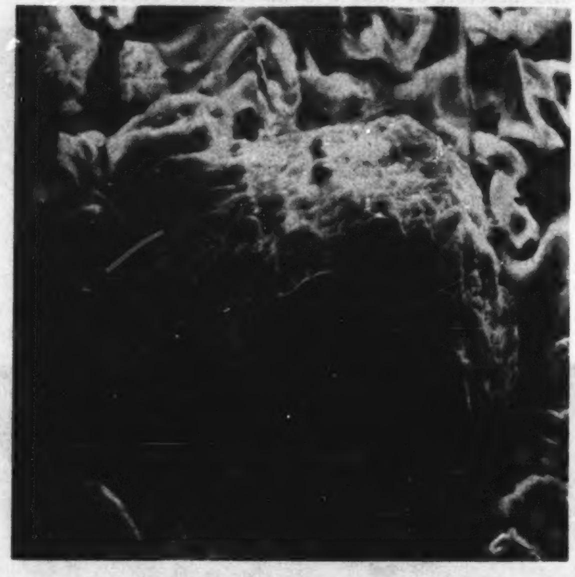
The new facility is expected to make important contributions to research programs to develop the next generation of aircraft which will fly much more quietly and efficiently than today's models.

The increased capabilities of the modified facility will help meet the critical need for testing full-scale aircraft systems under simulated flight conditions. As the trend continues toward the development of aircraft and helicopters of increasing size and complexity, it has become increasingly difficult to accommodate them in existing wind tunnel facilities.

An important use of the new facility will be for low-speed testing of aircraft with engines operating. Such studies are important in reducing aircraft noise during landings and takeoffs, in developing high-lift systems to reduce takeoff and landing distance, and in improving flight performance of airplanes in congested terminal areas.

The modified facility will essentially be two complete wind tunnels which share a common drive system. The 12-by-24-m test section will operate as always, except for the increased speeds available. Airflow through the new 24-by-37-m test section will enter through the intake at the end of the leg, flow through the test section and drive systems, and exhaust through vanes which will be installed in the south wall of the existing structure. Since both test sections share the common drive system, it won't be possible for both test sections to operate simultaneously.

Total cost of the modification project, $85 million, represents only a small portion of the cost to build an entirely new wind tunnel. Shutdown of the 40 by 80 circuit is expected to be complete in mid-July 1981. The compelte facility is expected to be fully operational in early 1982.



Volcanic Ash Amplified—The closeup is of a large dust particle from Mount Saint Helens, picked up after one of the summer eruptions. Magnification is 541 times the actual size and it was accomplished by the scanning electron microscope in the Goddard Space Flight Center's Parts Analysis Laboratory at Greenbelt, Md. Assistant engineer Diane Casper of the Sperry Support Service Group made the picture, using a microscope normally employed to inspect spacecraft circuitry and flight systems components. The volcanic ash is a crystaline structure of predominant silicon composition, with traces of sulphur, calcium, potassium and a vestige of iron.

One Magazine's Comment

In a recent edition of Government Executive magazine, the Publisher's Note column was entirely devoted to the space agency. Here, in part, was what it said:

A remarkable publication just came out of the National Aeronautics and Space Administration called Spinoff 1980. It is an annual thing and describes, with devastating effectiveness, the incredible wealth generated and dropped into the U.S. economy by a relatively tiny Federal agency with a petty cash annual budget.

How many of us have heard over and over again, in living color on our TV sets, spokesmen for the nation's poor—in fashionable three-piece suits—ranting about "If we can land a man on the Moon Etc." You can fill the rest of the speech in yourself. The point is that little of the public funds used to get to the Moon stayed on the Moon. Over 99.999% was spent right here in the States. And since that program started almost twenty years ago, the so-called spinoffs have literally changed our way of life. Now NASA is struggling to get Space Shuttle off the ground—and if that agency has problems it is because, as usual, they are living on the final edge of human knowledge and ability. It is not because of graft, inept management, bureaucratic inertia and the other hallmarks of the rest of government . . . . . Here then is this agency called NASA that has long been the envy of the rest of government because of its uncanny ability to explain to the taxpayer exactly what it is doing and why—and then goes on and does it.

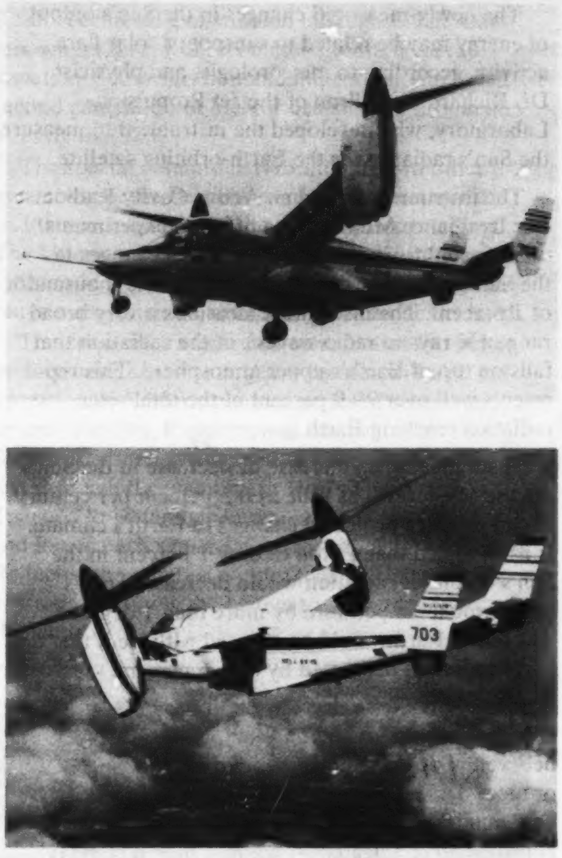
Dryden Receives Tilt-Rotor Plane

A new airplane that can take off and land like a helicopter and cruise in flight like a conventional aircraft was delivered to Dryden Flight Research Center in August.

Two XV-15 Tilt Rotor experimental aircraft were built for NASA and the U.S. Army by Bell Helicopter, Textron, Fort Worth, Texas. The second XV-15 aircraft is at NASA's Ames Research Center, Mountain View, Calif., preparing for research flight tests.

Because the XV-15 is capable of tilting its two wingtip mounted engines and rotors from the vertical to the horizontal position, the aircraft can fly as a helicopter, a short takeoff and landing aircraft, a conventional aircraft in forward flight or any combination of the three. Thus the aircraft can take off vertically as a helicopter and convert to the conventional aircraft mode in flight and gain the high-speed performance advantages of conventional aircraft.

The XV-15 aircraft received their initial flight tests at the Bell facility. The models delivered to NASA Dryden will be used to expand performance limits by NASA, military and contractor pilots. Then, the XV-15 aircraft at NASA Ames will be flown within these limits to perform specific research objectives. The flight program at Dryden is expected to last approximately one year.



DFRC's New Acquisition—By tilting its wingtip mounted engines and propellors, the XV-15A can take off like a helicopter and cruise like a conventional aircraft. The experimental craft is now at the Dryden center for a year of intensive testing.

Changes in Sun's Energy Noted

Using a measuring device flown in space for the first time, a NASA satellite has detected small changes—over periods of days to months—in the brightness of the Sun. Even the slightest change in the amount of light and heat energy emitted by the Sun is important because if a trend were to continue for several years, it could produce major alterations in the Earth's climate. Measurement of such trends might enable scientists to predict future climate changes.

Fluctuations of about one-tenth of 1 percent have been seen several times by an experiment aboard the Solar Maximum Mission satellite. These fluctuations in solar radiation correspond to a change of up to 10 degrees Celsius in the Sun's average temperature of about 5,700 C.

The newly-measured changes in the Sun's output of energy may be related to sunspot or solar flare activity, according to meteorologist and physicist Dr. Richard C. Willson of the Jet Propulsion Laboratory, who developed the instrument to measure the Sun's radiance for the Earth-orbiting satellite.

The instrument, called an Active Cavity Radiometer Irradiance Monitor, one of seven experiments on the satellite, is capable of detecting changes in the Sun's release of energy as small as one thousandth of 1 percent. The instrument measures a very broad range (X-rays to radio waves) of the radiation that falls on top of Earth's upper atmosphere. This represents well over 99.9 percent of the total solar radiation reaching Earth.

Theoretically, an increase or decrease in the Sun's release of energy—as little as 0.5 percent per century—can produce profound changes in Earth's climate. It is estimated that a drop of only 1 percent in the Sun's output of radiation would decrease Earth's mean global temperature by more than 1 degree C. The entire Earth would be covered with ice if the Sun's radiation decreased by only 6 percent.

There is evidence that the Earth has been growing colder for about 90 million years, and scientists believe the average global temperature may drop 10 or more degrees in the next several million years. One-hundred-fifty million years ago, Earth was approximately 8 degrees C warmer than it is today. Since then, numerous warming and cooling climate cycles have occurred. These cycles, which occur with frequencies ranging from 22 years to millions of years, have caused ice ages, ranging in severity from major glacial epochs to "little ice ages."

More Solar Flares—The arrow points to an unusual "corkscrew-like" streak of hydrogen bursting from the Sun's surface during an investigation by the Solar Maximum Mission. The orbiting laboratory is providing unprecedented information on changes in the Sun and its energy.

The last "little ice age," which began in the mid-17th century and lasted through the mid-19th century, was marked by a one-and-a-half degree drop from the present mean global temperature of about 14 degrees C. This slight change in the Earth's average temperature resulted in an observable increase of glaciation in the Alps.

The Solar Maximum Mission satellite, launched into a 575-kilometer orbit above Earth last February, is managed for NASA's Office of Space Science by the Goddard Space Flight Center.

The spacecraft's observations are part of NASA's solar monitoring program, now focused on studying the Sun during the Solar Maximum Year—a 19-month period when sunspot activity, which rises and falls in an 11-year cycle, is at a peak. Additional flights of a similar device, again supplied by Dr. Willson, will occur as part of NASA's Spacelab program. The latter will be carried into space aboard the Space Shuttle, beginning in the early 1980s.

Aircraft Emergency Signals Improved

NASA researchers believe they have solved some of the problems of general aviation aircraft distress signal equipment, in which six of every seven systems failed to transmit following a plane crash and approximately 75 percent of all distress signals were false alarms.

The systems, known as emergency locator transmitters, emit a radio beacon, on a specific frequency designated for emergency use, to locate downed aircraft and are supposed to be activated by the impact force of a crash.

Researchers at Langley Research Center assisting the Federal Aviation Administration through the Radio Technical Commission for Aeronautics, think they may have an answer to at least one of the activation problems.

The trouble lies in the self-contained, battery-powered radio beacon's sensor switch. In some cases the switch has proven too sensitive to normal aircraft vibrations while, in other instances, the switch was not sensitive enough to crash forces.

To activate the radio beacon on impact, the sensor switch must "feel" a force of five times gravity for more than 11 milliseconds. High-frequency vibrations where the beacon is mounted, however, can make and break the contact more rapidly than the 11 milliseconds, allowing the device to ride through a crash without activating.

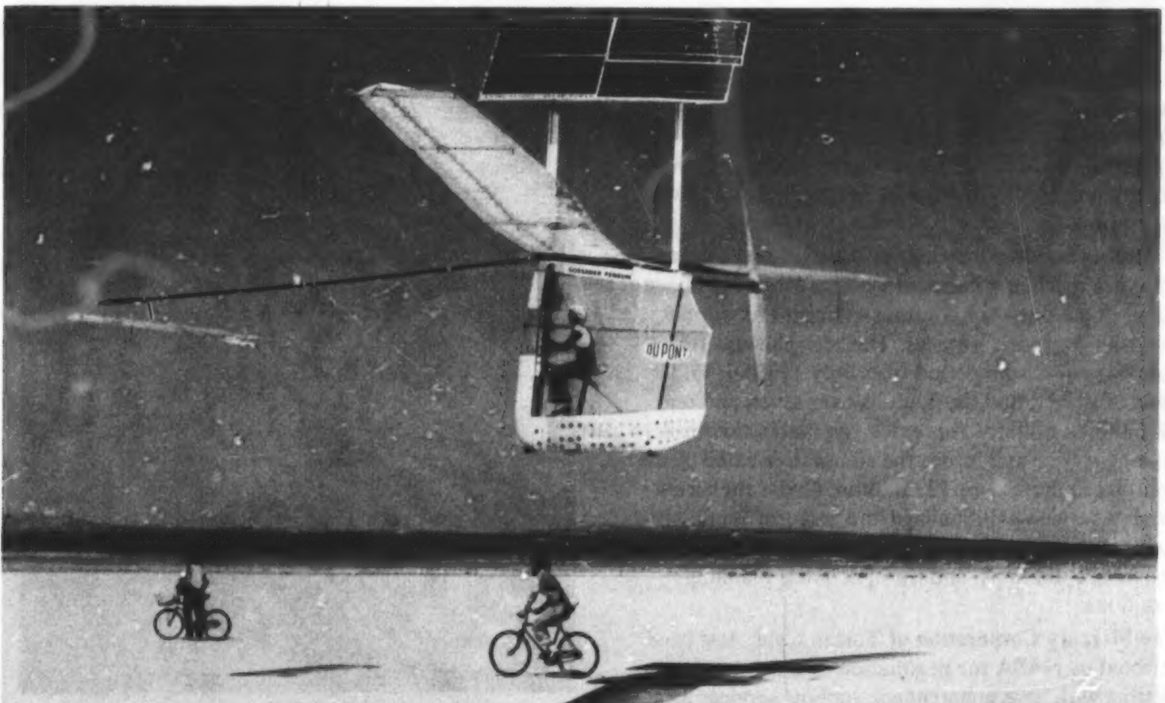
Somewhat lower frequencies may cause false alarms, but even lower frequencies are present during a crash. Scientists have built an experimental switch sensitive to low-cycle vibrations out of the range of normal aircraft vibrations and closer to the low-cycle, pulse-like force of a crash.

Huey D. Carden, an aerospace engineer at Langley, designed the modification and tested it. The device was attached to various places inside a section of tail cone from a light airplane, which was in turn, inside a protective cylindrical section. The entire 907-kilogram assembly was dropped several feet into a .6-meter depth of glass beads, subjecting the sensor switch to forces as high as 16 times gravity. The same procedure, as well as crash tests using actual aircraft, was initially used to evaluate the problem with the locator beacon.

Carden made his report to a special committee of Radio Technical Commission in August. The Commission, in turn, will recommend to the Federal Aviation Administration and industry an improved second generation of locator beacons for production as early as 1983.

The special committee is examining two other areas: where the beacons were or were not useful, and the performance of the beacons as a total system. The latter group has already determined that antenna location in a downed aircraft strongly influences the range over which the distress signal can be detected.

The committee's expected contributions to better performance of the emergency locator will also aid operation of NASA's planned series of search and rescue satellites. Experimental hardware for SARSAT, as the system will be called, will be flight tested on another satellite in 1982. The system is designed to instantly process many distress signals and locate each signal source to within 10 kilometers. Reducing the number of false locator beacon transmissions will allow the system to operate more efficiently.



Direct Solar Flight—The Gossamer Penguin soars over the flat surface of Dryden Flight Research Center, without storage batteries and relying solely on solar power. The 68-pound aircraft has a bank of 2800 protovoltaic cells mounted above the wing and they convert light from the Sun into electricity to power the propellor. Janice Brown is at the controls.

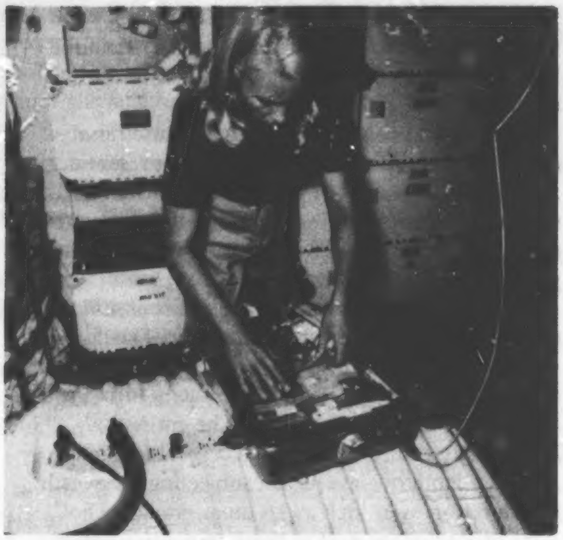
A Working Day—Johnson Space Center employee Shirley Price parks her car and prepares to walk to her office in the Project Management Building. Totally independent, the 34 year old woman has been without arms since birth. She does her own housework and personal grooming, and she can type with her toes. Employed in the JSC Personnel Office, Ms. Price is a former recipient of the National Handicapped Woman of the Year Award.

Contractor News

McDonnell Douglas Corporation, McDonnell Douglas Astronautics Company, 5301 Bolsa Avenue, Huntington Beach, Calif., has been awarded a letter contract for long lead time materials for six Delta space vehicles plus related spares. The value of the letter agreement approximates $14 million and will be negotiated as a fixed price incentive contract. Technical direction of the Delta program is performed by the Goddard Space Flight Center under the overall direction of NASA's Office of Space Transportation Operations.

Boeing Services International, Inc., Cocoa Beach, Fla., has reached agreement with the Kennedy Space Center on a one-year contract extension for supply and transportation services. The cost-plus-award-fee contract covers the period from July 1, 1980, to June 30, 1981, and the figure is over seven and one half million dollars. This extension marks the third year of service and brings the cumulative value of the contract to more than $22 million. Under the terms, Boeing Services will manage and perform supply support operations and services, transportation management operations, and transportation planning functions.

The Mercury Corporation of Tustin, Calif., has been selected by NASA for negotiation of a contract dealing with base maintenance support services at the Marshall Space Flight Center. The cost-plus-award-fee contract is to begin in October and run for one year with two one-year options. Estimated three-year value of the contract would be $21 million.



Meals in Orbit—Not a busy housewife packing Johnny's lunch, she is Astronaut Rhea Seddon. At the Johnson Space Center, she is assembling food items for the portable food warmer to be used on Shuttle trips which have no galley (orbital test missions). The food warmer heats by conduction and will be attached to a locker door in the mid-deck area of the orbiter.

Visual Effect—With most of the NASA facilities reporting heavy visitor turnouts, September activiies at LeRC's Visitor Information Center featured this handsome Shuttle model. The orbiter, 8-feet, in length, has its cargo bays open, showing Spacelab tucked inside.

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Donald G. Beremand, NASA/Lewis	Free-piston regenerative hot gas hydraulic engine	4,215,548	LeRC
Hossein Bahiman, NASA/GSFC	Belt for transmitting power from a cogged driving member to a cogged driven member	4,215,590	GSFC
John A. Calvert, NASA/MSFC	Redundant motor drive system	4,215,592	MSFC
Samuel Berkman, Kim Kyong-Min Harold E. Temple, RCA Corp., David Sarnoff Research Center, Princeton, N.J.	Means for growing ribbon crystals without subjecting the crystals to thermal shock-induced strains	4,216,186	NRO/JPL
Theodore F. Cizek, IBM Corp.	Method for growing a ribbon crystal particularly suited for facilitating automated control of ribbon width	4,217,165	NRO/JPL
Charles E. Hermesmeyer Motorola, Inc., Phoenix, Ariz.	Method and apparatus for quadriphase-shift key and linear phase modulation	4,216,542	NRO/JPL
Warren H. Philipp, Charles E. May Li-Chen Hsu, Dean W. Sheibly, NASA/LeRC	Method of cross-linking polyvinyl alcohol and other water soluble resins	4,218,280	LeRC
Michael J. Mirtich, Jr., James S. Sovey Robert F. Roman, NASA/LeRC	Hydrogen hollow cathode ion source	4,218,633	LeRC
I-Ping Yu, Lockheed Electronics Co., Inc. Houston, Tex.	Multiple band Circularly polarized microstrip antenna	4,218,682	JSC
Ellis Haynes, Jr., Rockwell International Corp., Space Systems Group, Downey, Calif.	Coaxial phased array antenna	4,218,685	JSC
Walter J. Matzen, Texas Instruments, Inc., Dallas	Apparatus for measuring semi-conductory device resistance	4,218,650	NRO/JPL
Norris C. Gray, Robert M. Senseny Philip N. Bolton, Boeing Aerospace Co., Seattle	Penetrator nozzle	4,219,084	KSC
Allen G. Ford, Caltech/JPL	Speed control device for heavy duty shaft	4,219,107	NRO/JPL
William A. Oran, Leroy H. Berge Donald A. Reiss, Jerry L. Johnson, NASA/MSFC	Method and apparatus for shaping and enhancing acoustical levitation forces	4,218,921	MSFC
John Bellavia, Jr., John O. Kane Rockwell International Corp., Space Division, Downey, Calif.	Thermal barrier pressure seal	4,219,203	JSC
James B. Stephens, Caltech/JPL	Low cost cryostat	4,218,892	NRO/JPL
Arthur A. Rudmann, NASA/GSFC	Device for coupling orbiting space vehicles	4,219,171	GSFC
Manuel A. David-Malig United Aircraft Corporation, United Technology Center, Sunnyvale, Calif.	Method and tool for machining tranverse slot about bore	4,218,941	LaRC
Gordon F. Lund National Research Council, Washington, D.C.	Improved subcutaneous electrode structure	4,219,027	ARC

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January 17	Atlas Centaur	ESMC	DOD Navy. Reimbursable.
SMM-A	February 14	Delta	ESMC	NASA. Scientific Solar Maximum Mission.
NOAA-B	May 29	Atlas-F	WSMC	NOAA Weather. Reimbursable. Launch vehicle failed.
GOES-D	September 9	Delta	ESMC	NOAA Weather. Reimbursable.
SBS-A	October	Delta	ESMC	Satellite business systems. Reimbursable.
FLTSATCOM-D	October	Atlas Centaur	ESMC	DOD Navy. Reimbursable.
Navy 20	November	Scout	WSMC	DOD Transit. Reimbursable.
Intelsat V-A	November	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

Did You Know?

The last member of the famed "von Braun team" has left the Marshall center. Gustav A. Kroll retired in July after working on projects at Huntsville since 1950. Kroll arrived in the United States with the 118-member von Braun rocket group in 1945 and lent his talents in structure to all the major Marshall projects—Redstone, Jupiter, Saturn, Shuttle. Mr. Kroll and his wife will stay in Huntsville; that, to the Krolls, is home.

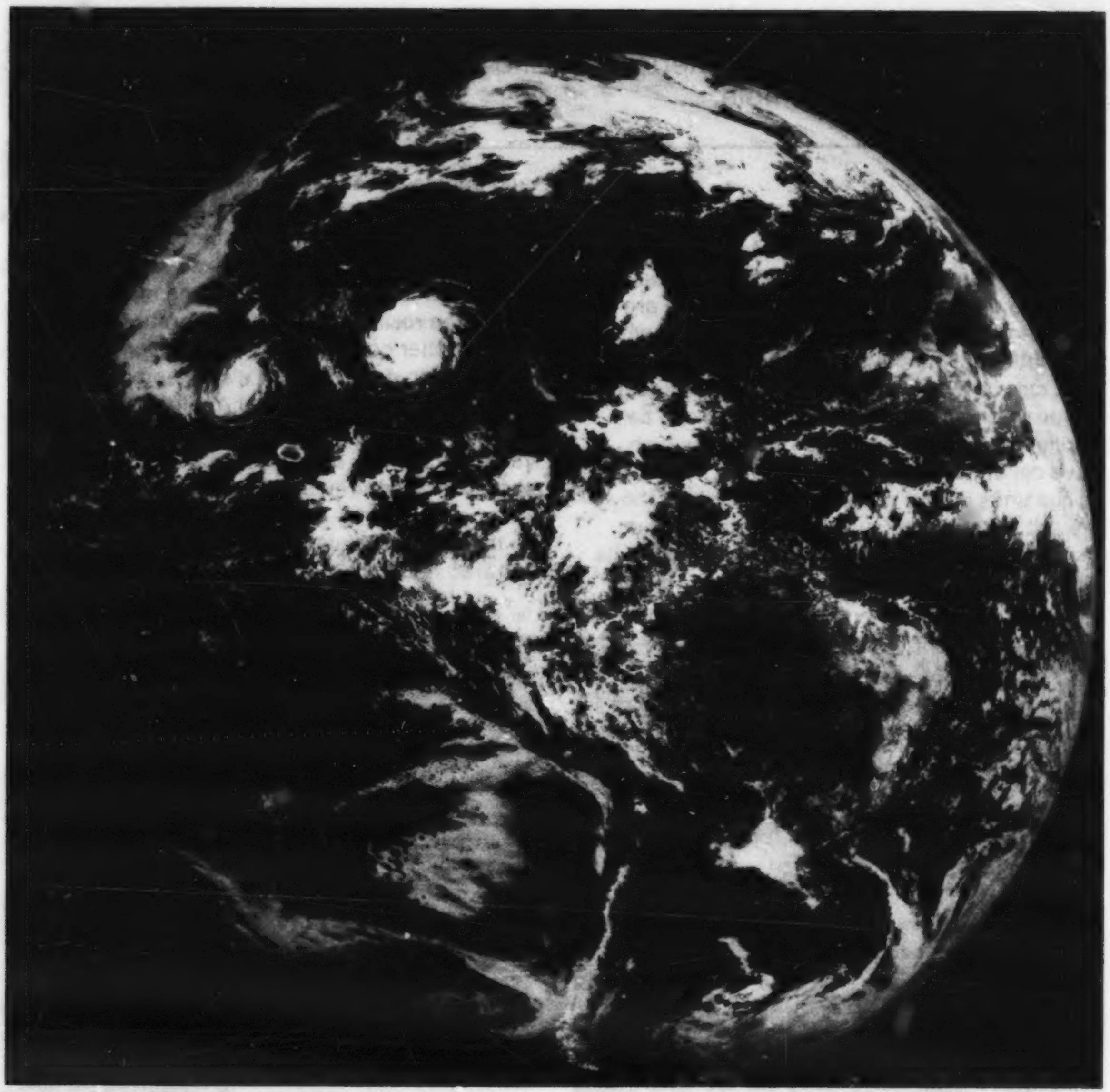
The Lewis center and Case Western Reserve University have completed their 17th year of the Faculty Fellowship Program. This year, thirty-one professors from colleges and universities across the country studied at the ten-week program, all under the auspices of the American Socity for Engineering Education. Under the program, academicians are given the opportunity to work side-by-side with NASA researchers on a wide variety of projects.

Clarice Lolich, aerospace education specialist, has been named Teacher Educator of the Year by the American Society for Aerospace Education. A visiting assistant professor with Oklahoma State University, Ms. Lolich travels as an aerospace lecturer representing NASA in the Western United States. She is based at Ames Research Center.

Idea Clearinghouse, the voluntary NASA Headquarters program to publicize operations improvements, has gotten a good response from various centers. To keep that ball rolling, Activities lists below the idea program coordinator at each installation with the phone number.

At	*Contact*	*Ext.*
ARC	John McDermaid	5667
DFRC	Bud Merritt	8457
GSFC	Pat Kelly	8494
JSC	Merv Hughes	5228
KSC	Raymond Cerrato	2780
LaRC	William Simkins	3511
LeRC	Mike Hoyman	6694
MSFC	Leroy Osborn	0600
NSTL	Tom Worthington	2000
WFC	J. C. Floyd	5581
Headquarters	James Darraugh	755-3219

For more information, contact Headquarters Information Systems Division (NSM-12).



Hurricane by Satellite—The immensity of Hurricane Allen is shown clearly in this photo taken on August 8 by a NOAA meteorological satellite designed by NASA. After devastating wide areas of the Caribbean, Allen is barreling toward the Texas coast. The storm covers almost the entire area of the Gulf of Mexico. The satellite picture also captures a hurricane named Isis, which was on the rampage in the Pacific at the same time. Note the simplicity of weather patterns across the United States—barely a cloud overhead anywhere—as the nation suffered through this summer's prolonged heat spell.

Another Dividend from Air and Space

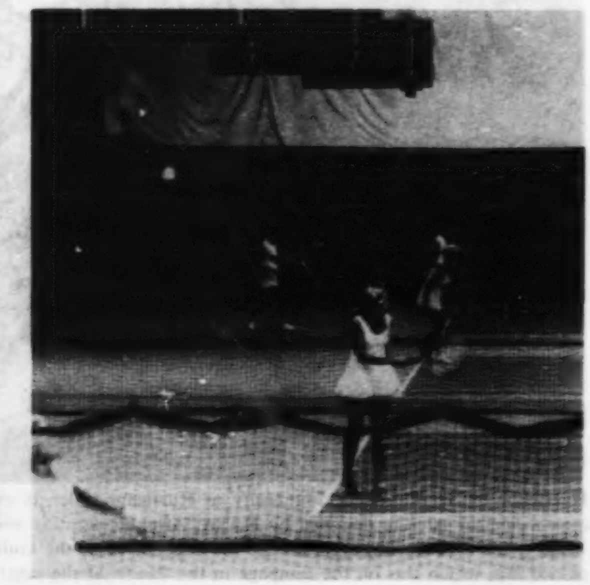
Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Infrared Heaters

In such diverse places as a CVA Lincoln-Mercury shop in Gaithersburg, Maryland, and the Bare Hills Tennis Club in Baltimore, heating units are operating from the ceiling. They are Panelbloc infrared heaters, energy savers which burn little fuel in relation to their effective heat output. Produced by Bettcher Manufacturing Corporation of Cleveland, Panelblocs can be applied to industry and other facilities which have ceilings more than 12 feet high.*

The units do not waste energy because they are not warming the surrounding air. Instead, they beam invisible heat rays directly to objects which absorb the radiation—floors, machinery and people. All of these objects in turn re-radiate the energy to the air.

A key element in the Panelbloc design is a coating applied to the aluminized steel outer surface of the heater. This coating must be corrosion resistant at high temperatures. When the Bettcher company was looking for the right materials to develop such a spray-on paint, it turned to a NASA Industrial Applications Center. NASA responded with pertinent reports on radiator coatings used on spacecraft, including the Apollo Lunar module. Bettcher then set up its own coating facility, at a savings and adding to the radiant efficiency of the company's infrared heaters.



For the benefit of all . . .

NASA
National Aeronautics and
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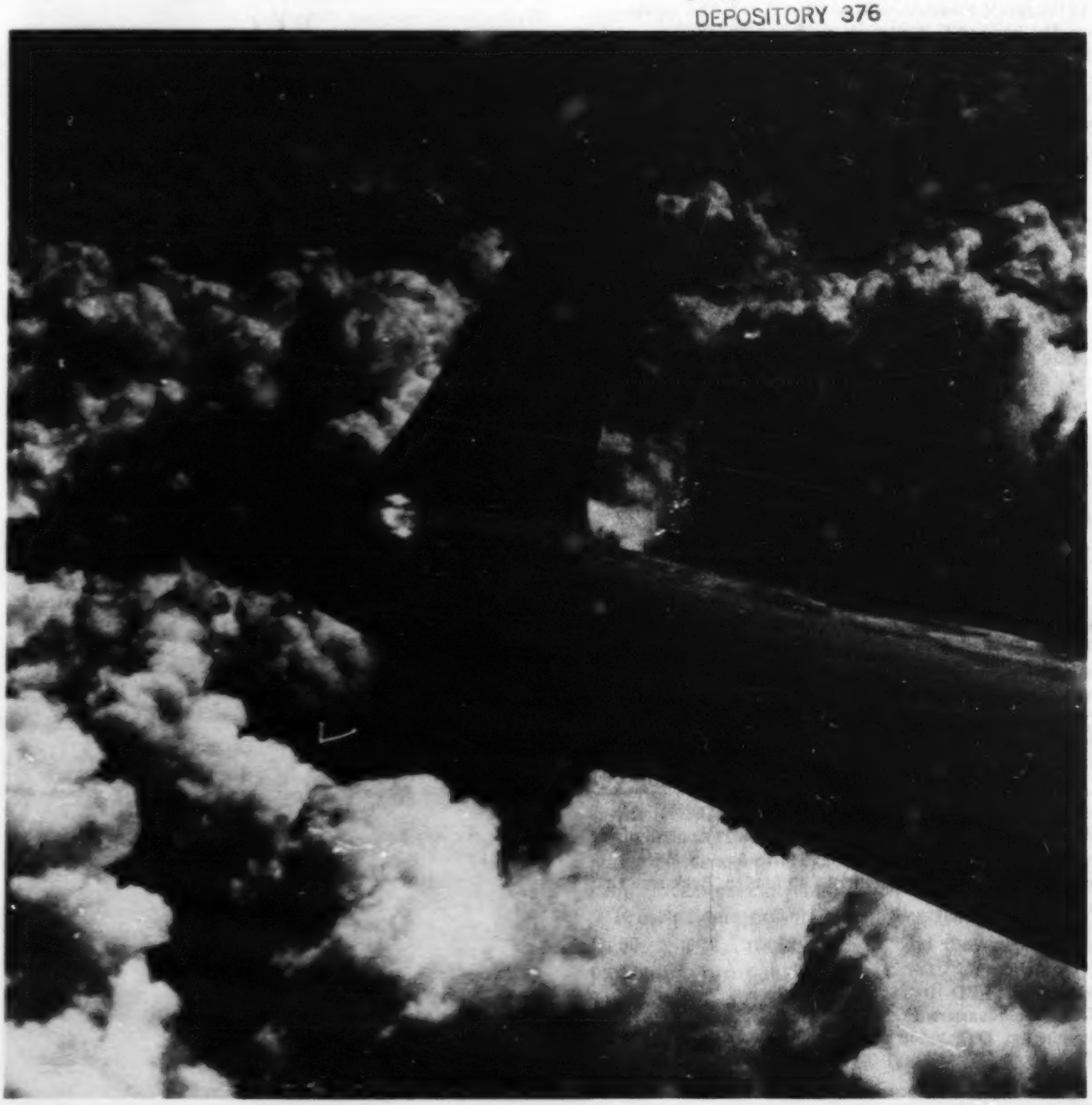

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COVER

Sailing at Jet Speed—The almost vertical appendage to the wingtip, resembling a small jib sail, is called a winglet. The plane is a new Learjet Longhorn 55, which makes its service debut this year. Gates Learjet was the first manufacturer to use the winglet design in production jet aircraft and with NASA cooperation, the Air Force has now begun testing them on Strategic Air Command tanker planes.

Winglets are lifting surfaces which operate in the vortex, the air whirlpool at an airplane's wingtip which creates drag. The winglet not only reduces the strength of the vortex but also generates its own lift, producing forward thrust in the manner of a boat's sail. The combination adds up to significant improvement in fuel efficiency.

In the recent Presidential Rank awards to NASA executives, Dr. Richard T. Whitcomb, retired aeronautical research manager at the Langley center, was honored for his work in developing the area rule, the supercritical wing and the winglet. "Radical departures from aerodynamic theory", the award stated, that have "resulted in revolutionary advances in aircraft performance."

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Letter from Washington

Dear Colleagues:

As you will remember, we made a commitment last July, after a thorough examination of the Shuttle program, to launch Columbia on the first orbital test flight in March of 1981. In making that commitment, we recognized that this was a tight schedule, requiring exceptional dedication, judgement and leadership throughout our agency for success. I am glad and proud to be able to report, tight as it is, that schedule is holding. Most program milestones have been met on time. Barring some major, unforeseen difficulty, Columbia will roll-out from the Orbiter Processing Facility later this month and enter the intensive 15-week period of preparation for launch.

All concerned have acted in the NASA tradition of excellence, and in doing so have reenforced and extended that tradition. Congratulations at this point would be premature—but a hearty "Well done!" is not.

Let us continue down the course we have set until that day in March when the hard work of all these years comes to audible and visible fruition on Pad 39A at KSC.

Sincerely,

A. M. Lovelace

A. M. Lovelace

Dr. Frosch to Leave NASA

Dr. Robert A. Frosch has informed President Carter that he plans to leave his post as Administrator of NASA in January. He is the fifth man to head the nation's civilian space agency.

Frosch will be taking over as the first president of the American Association of Engineering Societies (AAES), a federation, created in January 1980, of the major engineering societies in the United States.

After notifying the White House, Dr. Frosch had distributed the following message to all NASA personnel:

"Dear Colleagues:

I have informed President Carter that I will be leaving the position of Administrator of NASA on 20 January 1981. I do so for personal reasons; I can no longer ignore the competitive opportunities available to me and to my family in private life. A unique opportunity particularly suited to my interests has arisen and I must take it.

Working in NASA has been a rewarding experience, both because of the nature of the work, and because of the wonderful, competent people doing it. I deeply appreciate the marvelous cooperation and support I have received from all of you during my tenure. I am confident that our programs will be successful and that NASA will have an opportunity for even greater service to the country and the world than before.

While I will no longer be serving with you directly, I continue to be devoted to our common interests in aeronautics and space and to the advancement of science, technology, and engineering."

Frosch was nominated by the President to become Administrator of NASA on May 23, 1977, and took his oath of office on June 21, 1977. Previously, he had been Associate Director for Applied Oceanography at Woods Hole Oceanographic Institution from 1975 until mid-1977.

A native of New York City, Frosch earned a bachelor's degree in 1947, a master's degree in 1949 and a doctorate in 1952 in theoretical physics, all from Columbia University, New York.

Frosch is married to the former Jessica Rachael Denerstein of Brooklyn, N.Y., and they are the parents of two daughters.

Busy Year for Expendables

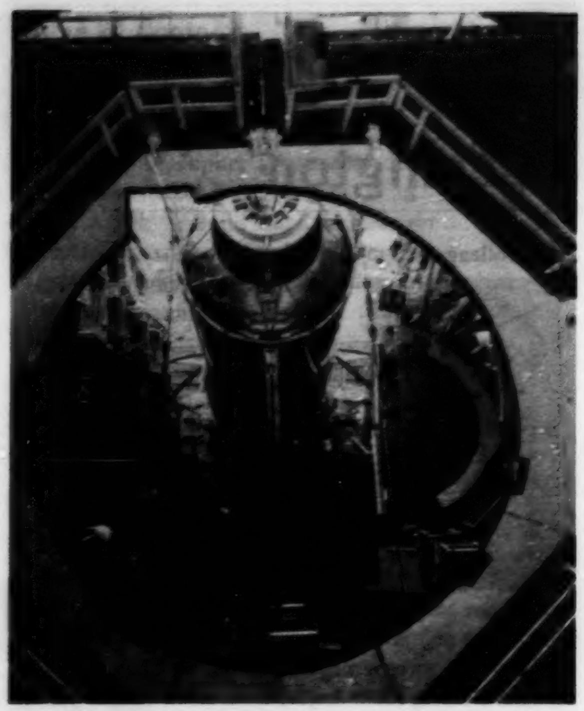
NASA will conduct 18 space missions using expendable vehicles through the end of September 1981, according to Joseph B. Mahon, Director of the Expendable Launch Vehicles Program.

The full schedule involves launching a variety of scientific, weather, communications and Department of Defense satellites from launch sites located at the Eastern Space and Missile Center, Cape Canaveral, Fla.; the Western Space and Missile Center, Vandenberg Air Force Base, Calif.; and the Italian-operated San Marco launch platform in the Indian Ocean off the coast of Kenya.

Seven of the 18 missions will be flown on Delta launch vehicles; seven on the Atlas Centaur; three will use the solid-fuel Scout; and one, the Atlas-F.

Two of the flights will carry scientific satellites, while the remaining 16 will be conducted for other government agencies and private firms for which NASA will be reimbursed. These include three weather satellites sponsored by the National Oceanic and Atmospheric Administration, five Department of Defense payloads and eight commercial geosynchronous communications satellites for Satellite Business Systems, McLean, Va.; Radio Corporation of America, Piscataway, N.J.; and Comsat General Corp. and the Intelsat Consortium, both of Washington, D.C. The expendable launch program is directed by the NASA Office of Space Transportation Operations, Washington, D.C.

Date	Mission	Launch Vehicle
October 28, 1980	FLTSATCOM-D	Atlas Centaur
November 1980	SBS-A	Delta
November 20, 1980	Navy-20	Scout
December 4, 1980	INTELSAT V-A	Atlas Centaur
February 19, 1981	COMSTAR-D	Atlas Centaur
March 1981	GOES-E	Delta
March 12, 1981	INTELSAT V-B	Atlas Centaur
April 1981	SBS-B	Delta
May 1981	Navy-21	Scout
May 1981	NOAA-C	Atlas-F
June 1981	RCA-D	Delta
June 2, 1981	FLTSATCOM-E	Atlas Centaur
June 18, 1981	INTELSAT V-C	Atlas Centaur
July 1981	Dynamic Explorer	Delta
August 1981	Navy-22	Scout
September 1981	Solar Mesospheric Explorer	Delta
September 1981	INTELSAT V-D	Atlas Centaur



Finale for 1980—Looking down from the top of the gantry at NASA Launch Complex 36B, the first stage Atlas Booster is seen in place. Outside the gantry at Cape Canaveral Air Force Station, in the bottom picture, the second stage Centaur is hoisted up to mate with the Atlas first stage. Atlas-Centaur will boost Intelsat V-A, a communications satellite, into orbit no earlier than December 4 in the last launch of the year.

16th Moon of Jupiter Discovered

Dr. Stephen P. Synnott, a Voyager Project navigator at the Jet Propulsion Laboratory, Pasadena, Calif., who discovered a 15th moon of Jupiter last spring, has done it again. He has discovered a 16th Jovian satellite while searching through photos taken last year by NASA's Voyager spacecraft to confirm the discovery of a 14th satellite.

Synnott's newest discovery, tentatively numbered 1979 J3, is about 40 kilometers in diameter. It circles the planet once in 7 hours, 4 minutes, 30 seconds, with an uncertainty of three to five seconds.

This latest find came from the same process in which he found the 15th satellite in March 1980. Synnott believed at that time that he had confirmed the earlier sighting of the 14th satellite because they had similar orbits and sizes.

The new 16th satellite appears to orbit near the outer edge of Jupiter's ring—also discovered in Voyager photos. The orbit is about 56,200 km above the cloud tops. Synnott still has not confirmed the existence and the orbit of the satellite 1979 J1, discovered in October 1979 from Voyager 1 data.

"I've looked at hundreds of frames," Synnott says, "but it's either too small to see in the pictures or the pictures didn't happen to be taken at the right instant."

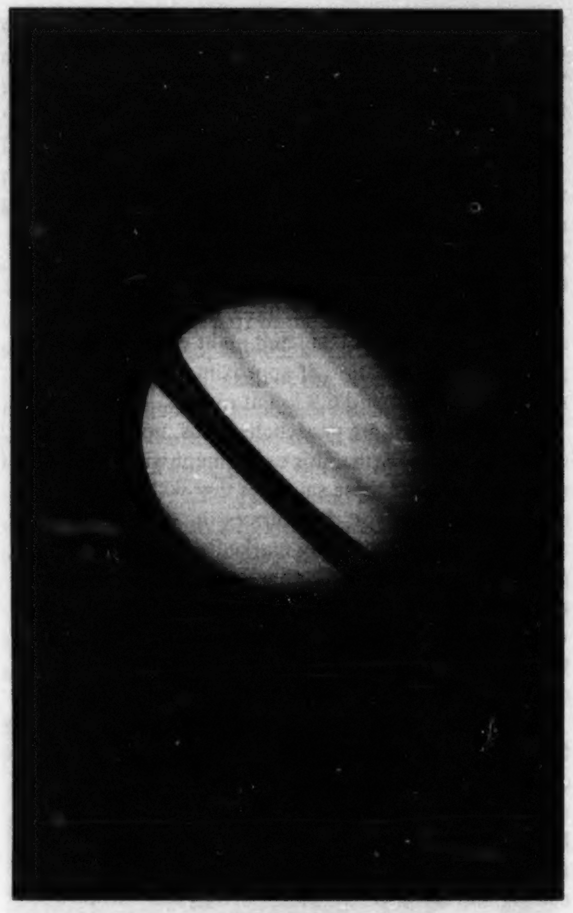
Before Voyager 1 reached Jupiter, the planet was believed to have 13 satellites. But in October 1979 a 14th was found (the one Synnott has not been able to confirm). Synnott discovered the 15th Jovian satellite last spring. His latest discovery, number 16, was made this July.

The two Voyager spacecraft are enroute to Saturn after their successful encounters with Jupiter last year. Voyager 1, now into its early encounter phase with Saturn, will make its closest approach on Nov. 12, 1980. Voyager 2, nine months behind, will arrive Aug. 26, 1981. Its trajectory will then take it on to an encounter with Uranus in January 1986.

New Storm Watcher in Space

The GOES-D meteorological satellite, launched Sept. 9 from the Kennedy Space Center for the National Oceanic and Atmospheric Administration, carries a new type of instrument known as the VAS, or Visible Infrared Spin Scan Radiometer (VISSR) Atmospheric Sounder.

Scientists at NASA's Goddard Space Flight Center,



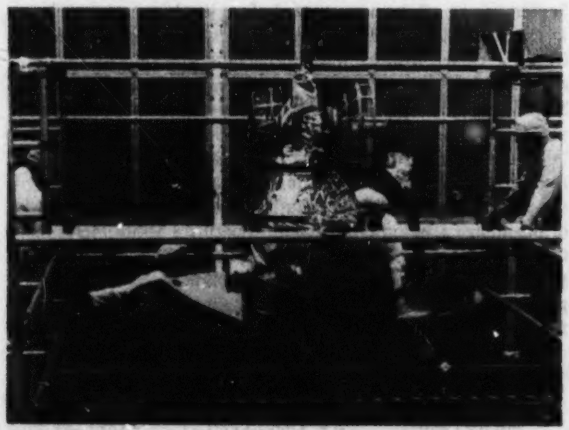
View from Voyager—This is Saturn, taken by Voyager 1 on September 12, about nine weeks before its closest approach to the planet. At that time, Voyager was 81 million kilometers from the ringed wonder and approaching at a velocity of abou 1,330,000 kilometers per day. In early March 1980, Saturn was at the point in its orbit where the Sun was in the plane of its rings; and since then, the Sun has been slowly "rising" on the northern side of the rings. At the current illumination angle of 30, the rings appear much darker than the planet itself, unlike most Earth-based photograph. Obvious in this image are numerous bands in Saturn's atmosphere, the Cassini and Encke Divisions in the rings, and the ring's shadow on the planet. The Cassini Division is the more prominent gap in the ring's brightness and the Encke is the fainter gap near the ring edge.

Greenbelt, and the University of Wisconsin at Madison, will conduct a long-term experiment to evaluate the usefulness of this instrument for prediction of severe local hurricanes, storms and other short-term weather phenomena.

Previous GOES spacecraft provided day and night, two-dimensional cloud cover photos. Now, the new atmospheric sounder, in addition to this same imaging capability, will be able to measure atmospheric temperatures and moisture at various altitude layers. As with previous GOES satellites, the new instrument will provide both day and night cloud cover photos with a resolution of approximately 0.9 kilometers in daylight and 6.9 km at night.

GOES satellites are geosynchronous, hovering over one spot on the Earth. This experiment will inaugurate a new use for these satellites that will require observation scenarios, data processing systems and analysis programs differing markedly from those for polar (north-south) orbiting weather satellites such as the TIROS-N series. Since GOES is stationary with respect to the Earth, it can observe storms as they develop and hence should be useful in a forecast and warning system.

Over the past few years, scientists from NASA, NOAA and the University of Wisconsin have been developing ground-based data processing facilities at Goddard and the University. These facilities will be used during the next few years in this experiment to assess the usefulness of VAS data for weathercasting and for increasing understanding.



The Weather Eye—Technicians perform checkouts on the Geostationary Operational Environmental Satellite (GOES-D) before its September 9 launch from Cape Canaveral. The satellite will provide timely warnings of violent storms, will track hurricanes and collect environmental data—from rainfall to snow depths.

South Africa to Build Landsat Receiver

Dr. Robert A. Frosch, NASA Administrator, and Dr. David H. Jacobson, Vice-President of the South African Council for Scientific and Industrial Research have signed a memorandum of understanding for the establishment of a Landsat ground station at Hartebeesthoek, near Johannesburg, South Africa.

The agreement will permit the South African Council, an early user of Landsat data, to operate an antenna at Hartesbeesthoek; to receive, process, archive and disseminate Landsat data.

The agreement provides that the Council will make the Landsat data it receives available on a public, non-discriminatory basis to anyone requesting it. As a result current and prospective Landsat users in Southern Africa will be able to obtain regular, timely data coverage of their region. This data can make a valuable contribution to the national development efforts of the Southern African countries.

In addition to paying for a ground station and attendant costs, the Council also agrees to pay NASA the current annual access fee of $200,000 beginning after the first six months the South African antenna begins receiving data.

Nine foreign Landsat ground stations are already in operation outside the United States: Prince Albert, Saskatchewan and Shoe Cove, Newfoundland, Canada; Cuiaba, Brazil; Fucino, Italy; Kiruna, Sweden; Tokyo, Japan; Hyderabad, India; Alice Springs, Australia; and Mar Chiquita, Argentina. Procurement of ground station equipment is underway in Thailand and China and a number of other ground stations are in the planning stages.

U.S. ground stations for Landsat are located at Fairbanks, Alaska; Goldstone, Calif.; and at NASA's Goddard Space Flight Center, Greenbelt, Md.

Landsat data are used by scientists and local officials in the United States and more than 100 foreign countries for a wide variety of applications ranging from crop inventories to flood assessment and mineral exploration.

Langley Researchers Study Lightning

Contrary to the old saying, lightning does strike twice in the same place. Confirmation is offered by the National Severe Storms Laboratory in Oklahoma, and personnel from NASA's Langley Research Center, Hampton, Va.

A Langley team of 19 people can testify that lightning not only struck twice, but three times, as they intentionally guided a modified F-106B jet fighter through severe Southwest thunderstorms this summer.

The tests, done in conjunction with the National Oceanic and Atmospheric Administration storms lab at Norman, Okla., are designed to study lightning from the inside out. Most of what is known about lightning is a result of studies at ground level. Researchers want to know how lighting affects aircraft in flight. As a result, an ambitious program to study lightning in the midst of thunderstorms has a fighter-type airplane seeking to get hit by lightning.

One morning this summer, after attracting no more than a few Oklahoma raindrops on the windshield in more than two weeks of flights, pilot Jerry Keyser was startled by the team's first lightning strike.

"We (Keyser and fellow research pilot Perry Deal) were inside a cloud, with visibility about 152 meters (500 feet). There was heavy rain and moderate turbulence. It didn't look that bad. I probably didn't see the whole thing, but I did see a lightning bolt come out of the fog, horizontally, from right to left," said Keyser, a major on assignment from the Air Force.

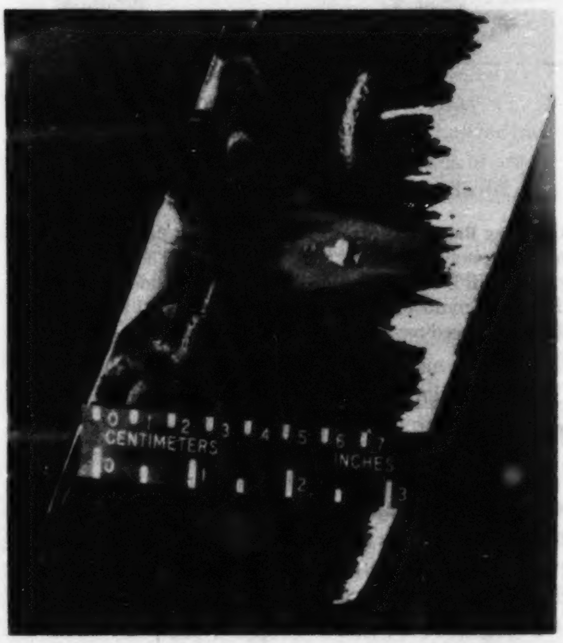
"It curved toward me," he continued, "I instinctively jerked the stick back in an avoidance maneuver. The bolt looked like a headless and tailless snake. It was incredibly fast. Even before I began to react, the 15-to-20 centimeter diameter 'snake' had struck the noseboom and spiraled down the left side of the airplane and was gone. I had my sunvisor down, just in case, and it was still fairly bright. There was a 'zap, crackle,' but there was no radio noise to warn of its coming."

"I was vastly relieved to hear my good friend Jerry Keyser say 'we just got struck,' " recalls mission director Norman Crabill, who for days had worked with storms lab radar controllers directing the craft into and through storm cells in pursuit of lightning. "It meant he was alive, the airplane was intact and that everything we had done to protect them had apparently worked. We had prepared extensively—including actually making tests on the ground with simulated lightning bolts—but this was the first real test."

A landing for an initial strike inspection was followed by an afternoon flight, piloted by Deal, that logged the project's two other direct lightning strikes. The second bolt also struck at the noseboom but the bolt split into streamers down both sides of the aircraft, one attaching to the top of the left wing, and the other attaching beneath the right wing. The third, after also striking the noseboom, "ducked under" to strike two probes located below the fuselage. We felt we had envisioned the lightning hazards pretty well," says Crabill, "not even a circuit breaker tripped."

Initial optimism faded a little, however, when the project's lightning consultant carefully inspected the aircraft after the team returned to Langley. He discovered that at least part of the second strike had skipped down the top middle of the left wing.

To the uninitiated, each of the several strike points might seem insignificant, no more than a rough, but shiny, spot on the wing that could have been caused by the twist of a knife point. But the top middle of the wing, away from the edges and wing tips, is not usually thought of as a lightning attachment zone, according to F-106B project engineer Bruce Fisher. "The thickness of the wing skin," he explains, "prevented a burn through to the underlying fuel tanks. In addition, a low volatility fuel (JP-5) is used in the aircraft to provide an additional margin of safety."



Easy Target—Like a man standing in an open field, this UHF radio antenna was a perfect mark when lightning struck a NASA F-106 over Oklahoma. The bolt hit the noseboom and ducked under to strike the radio probe. Most of the missing paint is due to rain erosion caused by flying through storms at 300 knots but halfway down the antenna is a burn off caused by the lightning.

The sleek fighter plane, capable of supersonic speeds, is on loan from NASA's Dryden Flight Research Center at Edwards, Calif. Even if NASA had not already owned an F-106B, however, it still would have been Langley's top choice for such a demanding mission. Besides thick wing skins, its tough construction has been likened to that of a tank. Its weapons bay is larger than average, making room—in the absence of weapons—for experimental equipment to be packed safely inside.

The F-106 is the holder of the world's single-engine speed record, set in the late 1950s. It is still used by the Air Force and can fly to 15,250 m. The NASA experiments are designed to work up to that altitude, although most flights will be aimed at thundercells around 4,500 m which is the freezing level and, statistically, the altitude where lightning is most likely to strike.

Lightning Bait—The rugged Langley F-106B flown by research pilots Perry Deal and Jerry Keyser. Though 22 years old, it is fast enough and thick skinned enough to be the ideal aircraft for lightning studies. The F-106 still holds the world speed record for a single engine jet.

Team for Mount St. Helens Mission

The space agency and a university research team joined forces in September to mount what scientists consider one of the most significant research missions ever undertaken to understand how volcanos affect Earth's atmosphere, weather and climate and their target is Mount St. Helens.

The mission used a NASA applications satellite, an aircraft crammed with the latest in laser and electronic remote and near sensing technologies, and the expertise of scientists from two NASA centers—Langley Research Center, Hampton, Va., and Wallops Flight Center, Wallops Island, Va.; Drexel University, Philadelphia; the Universities of Maryland, Arizona and Alaska; Dartmouth College, Hanover, N.H.; Michigan Technological University, Houghton; and the Oregon Graduate Center.

During the five-day mission, Sept. 17-21, NASA scientists took transcontinental laser radar soundings for the first time of the volcanic veil which still hangs in the upper atmosphere over the United States. They also obtained measurements of the quantities of certain gases—such as those in the sulfur family—that Mount St. Helens is ejecting into the atmosphere as a function of time.

In addition, the science team investigated how aerosols—or airborne particulates—are dispersed through the atmosphere. Their studies of the composition and morphology—or shape—of the particulates will also tell them something about what is going on inside the volcano.

The mission was a joint effort by the science teams for NASA's Stratospheric Aerosol and Gas Experiment satellite program, and the Research on Atmospheric Volcanic Emissions project, a NASA-funded operation conducted through the various universities. Both activities are elements of NASA's Climate Research Program managed by the Office of Space and Terrestrial Applications.

A typical mission combined a late-afternoon series of volcanic emission measurements in the vicinity of the volcano, followed by underflights of the satellite at dusk.

The satellite was launched in 1979 and has tracked the plumes of three volcanos including Mount St. Helens. The satellite uses a four-channel solar radiometer to take vertical profiles of ozone and aerosols in the stratosphere, which is of particular scientific importance because it is very stable atmospheric region, with no rain and little wind to carry away particles. It is here that the bulk of the ozone resides, which protects life on Earth from harmful wavelengths of solar radiation. The inputs of aerosols from volcanos have long lifetimes, and can possibly affect the weather and climate.

Another element of the mission included studying how sulfuric acid, the main component of acid rain, reacts with other chemicals in the atmosphere, thus adding to man's knowledge of this growing environmental concern. To gain this knowledge, the volcanic emission science team combined the capabilities of eight highly advanced and sensitive instrument packages developed over the past few years at the universities and research centers involved.

Rose Garden Recognition—President Carter, on the left, stands with 25 NASA employees who were honored with two Presidential Ranks—Distinguished Executive, for extraordinary accomplishment, and Metritorious Executive, for sustained accomplishment. The NASA Distinguished Executives, awarded lump sum payments of $19,517, were Dr. Anthony J. Calio, Headquarters; Dr. Christopher C. Kraft, Jr., JSC; William E. Lilly, Headquarters; and Dr. William R. Lucas, MSFC.

Unique Power Plant Possible

A six-month feasibility study has confirmed technical expectations for a unique power plant that could be built at NASA's Lewis Research Center in Cleveland. The plant would use high-sulfur coal without polluting the atmosphere and extract twice as much energy from the coal as under conventional methods.

Known technically as a coal gasifier cogeneration power plant, the facility would gasify high-sulfur coal to produce a clean fuel gas, burn the gas to produce electricity and recover waste heat to produce more electricity as well as heat for the Lewis Center's 130 buildings and test facilities.

Lewis estimates that the plant could be designed and built for $50-to-$70 million. Pending funding, design work could begin in 1981 with the plant in operation beginning in 1984. Funding options are being explored. The study was conducted for Lewis by Cleveland-based Davy McKee Corp., and the Cleveland Electric Illuminating Co. was a participant in the study.

Describing the proposed project, Dr. John F. McCarthy, Jr., Lewis Director, said: "The type of power plant envisioned by the study could have a dramatic effect on lessening this country's dependence on foreign oil and allowing the United States to use its abundant supplies of so-called dirty coal in an environmentally acceptable manner.

"The technology involved would be applicable potentially to the electric utility industry and to any industrial plant that is a heavy user of electrical and heat energy. Significantly, the plant would use proven technologies in coal gasification and cogeneration which means that commercial validity could be established in much less time than needed to prove new technologies."

Specifically, the study provided the conceptual design for a 20-megawatt power plant at Lewis. That would be sufficient power to furnish the center's base-load electrical needs and steam necessary for heating. It would be equivalent to the power needed to supply the electrical needs of approximately 5,000 homes. Peak steam capability will be 90,000 pounds an hour, a rate equal to that required for the average medium-sized industrial plant.

Site of the unique power station would be an existing but presently vacant parcel of land on the south side of the Lewis complex at 21000 Brookpark Road.

The plant would convert some 200 tons of coal a day into a clean fuel gas, equal to a saving of about 1,000 barrels of oil a day.

Lewis believes the new plant could provide savings of from $4-to-$7 million per year on its own fuel bills and reduce total energy consumption of the center by 10 percent from current levels.

In an operating version of the plant, crushed coal is blown into a fluidized bed gasifier (a vertical, cylindrical tank). There, the coal reacts with steam and air at a temperature of about 1,800 degrees Fahrenheit. Under these conditions, the coal is efficiently converted into a raw fuel gas which is drawn off at the top of the gasifier. The sulfur in the coal becomes hydrogen sulfide and come out of the tank as part of the raw fuel gas. A non-leaching, environmentally acceptable ash is withdrawn from the bottom of the gasifier.

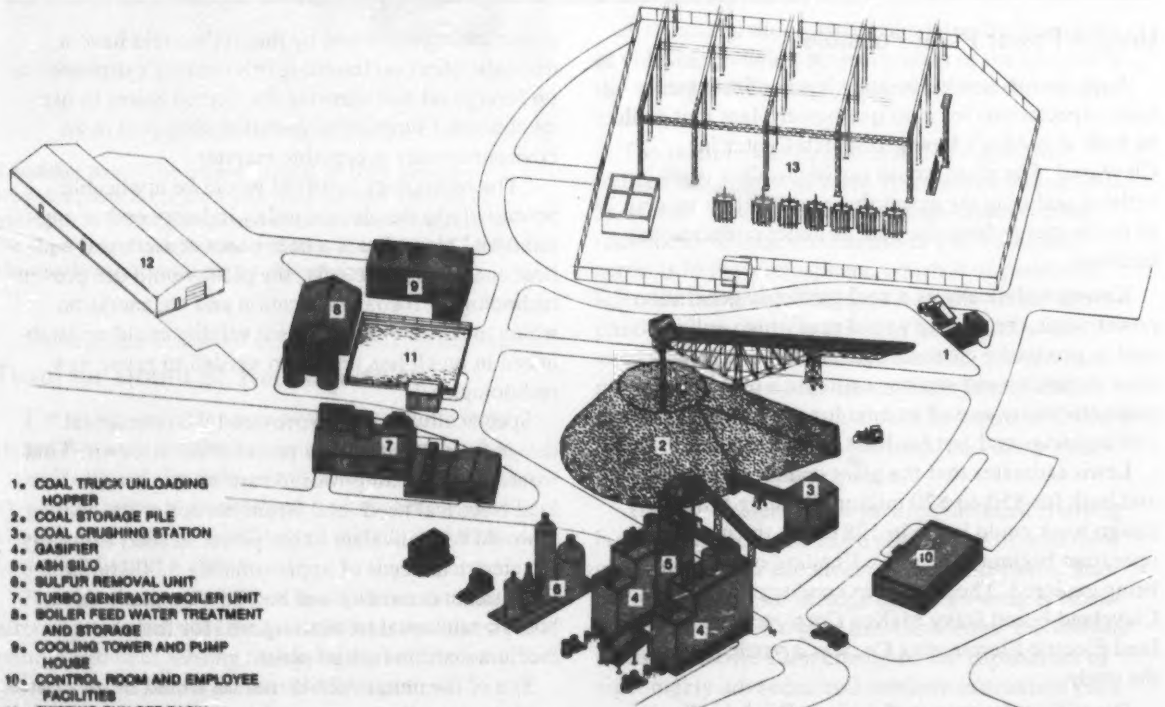
The hot raw fuel gas is cooled down in a heat exchanger where its heat is transferred to water thereby generating high-pressure steam for eventual use in a turbine.

The cooled fuel gas is passed through a clean-up system where suspended particles and gaseous pollutants are removed. The hydrogen sulfide in the gas is converted to elemental sulfur and recovered in the form of a powdered cake. There are a number of ways to dispose of sulfur in this form that have negligible impact on the environment.

The cleaned fuel gas is then burned in a gas turbine which drives a generator for the production of electricity. The hot exhaust from the gas turbine—normally vented to the atmosphere and thus wasted —is then directed through a heat exchanger where it produces high-pressure steam. This steam is combined with that produced in the raw gas cooler and is used either to power a steam turbine which can produce additional electricity or, as low-pressure steam, provide heating for buildings.

Both coal gasification and cogeneration technologies date back to the turn of the century. At one time, for example, coal lamps, using a low-BTU gas made from coal, furnished street lighting for many of America's main streets. Techniques of cogeneration (the recovery of waste heat from one energy source to serve as the fuel for making more energy in a secondary

COAL GASIFIER COGENERATION POWER PLANT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1. COAL TRUCK UNLOADING HOPPER
2. COAL STORAGE PILE
3. COAL CRUSHING STATION
4. GASIFIER
5. ASH SILO
6. SULFUR REMOVAL UNIT
7. TURBO GENERATOR/BOILER UNIT
8. BOILER FEED WATER TREATMENT AND STORAGE
9. COOLING TOWER AND PUMP HOUSE
10. CONTROL ROOM AND EMPLOYEE FACILITIES
11. EXISTING RUN-OFF BASIN
12. EXISTING STORAGE BUILDING
13. EXISTING SUB-STATION "A"

application) were being used by some 30 percent of the industrial plants in this country around the year 1900. The percentage had shrunk to about 5 percent by 1970 because of easy and expensive availability of oil and natural gas.

Lloyd I. Shure, chief of the Lewis Power Systems Branch and project manager for the gasifier/cogeneration project, noted: "The United States has greater coal reserves than any other nation, approximately 30 percent of the world's total supply. According to the Ohio Department of Energy, Ohio alone has an estimated 20 billion tons of recoverable coal. Most of this vast reservoir of energy remains untapped because most electrical generating plants are not designed to burn high-sulfur coal. Even if they were, they would need expensive and extensive scrubbers to meet environmental requirements."

Design Studies for Supercomputer

NASA has selected two corporations to do system design studies for its Numerical Aerodynamic Simulator, a specialized supercomputer, which will assist in developing and testing of new aircraft designs and other flight vehicles, and do general research in such fluid flow areas as meteorology, gas dynamics and computational chemistry. Value of each of the two parallel, firm fixed-price study contracts is $350,000.

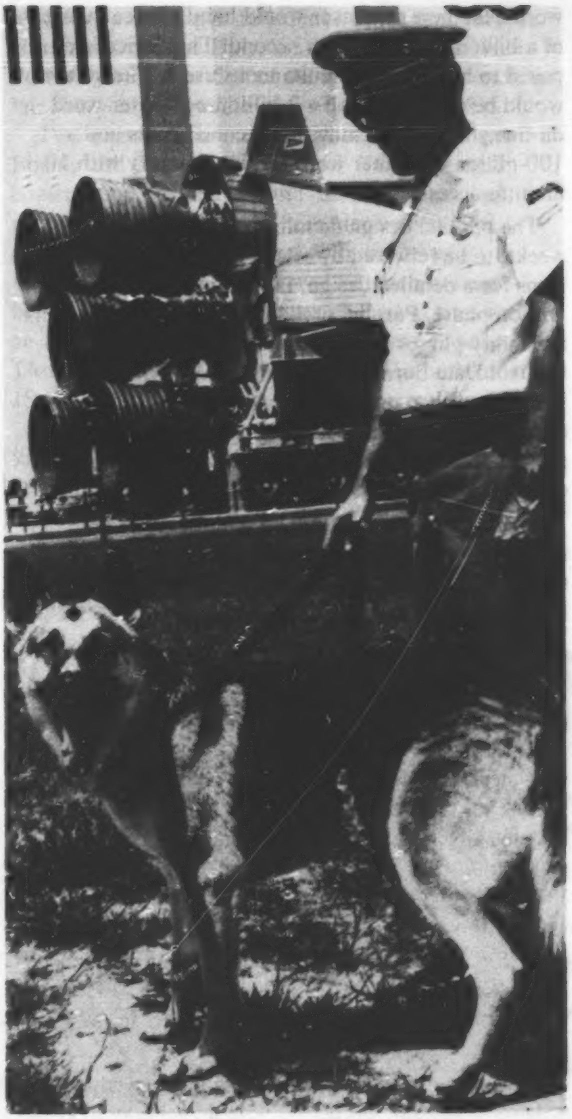
The studies are expected to result in a new data processor which may be 40 times faster than existing supercomputers, with a high speed memory 60 times larger than the current generation of supercomputers.

NASA's Ames Research Center, Mountain View, Calif., has selected for negotiation for the parallel design studies: Burroughs Corp., Federal and Special Systems Group, Paoli, Pa.; and Control Data Corp., Special Programs Division, Arden Hills, Minn.

The new specialized computer uses fluid flow equations to calculate continuously three-dimensional air flows at thousands of points simultaneously. This means the computer can simulate conditions of wind tunnel testing at far less expense than actual model tests in wind tunnels.

Computer simulation will complement wind tunnel tests by substantially reducing the amount of testing required for a particular new aircraft or flight vehicle design, and produce better designs.

Plans call for the proposed new computer to perform 1 billion operations per second using a data base of 40 million words. With a data base of 200 million



New KSC Personnel—The vigilant dog is Toby, age two and a half, and he poses with his owner and trainer, Sgt. William M. Morris, before the Vehicle Assembly Building at the Kennedy center. Toby joined the Wackenhut security services at KSC this summer and he has proved to be a highly versatile officer. He pulls patrol duty, traffic duty (riding with Sgt. Norris in the front seat), lost children details, and joins in secured area sweeps. Norris says his partner can pick up a scent at 300 yards and can sniff out the presence of the major illegal drugs. The dog is trained to attack and hold; if the subject is armed, Toby will disarm him. As the Kennedy center heats up, facing a tempestous time ahead with the Shuttle flights, it is also equipped to take a bite out of crime.

words, the new processor would handle three quarters of a billion operations per second. The device is proposed to handle 100 simultaneous users. The system would be equipped with a 2-billion-computer-word on-line storage system with 2 second access and a 100-billion computer word off-line memory with 10 minutes access.

The parallel design definition studies are for 40 weeks, to be followed by selection of one of the two firms for a detailed design, fabrication, test and integration phase. Parallel preliminary design and feasibility phases were completed by Burroughs and Control Data during 1977-1979, and work on the system has been underway at Ames since 1975. The design and fabrication phase is planned to be complete in five years, with the new data processor to be operational in October 1986.

The project is part of NASA's aeronautics research and technology program. Ames Research Center has project responsibility for the Numerical Aerodynamic Simulator.

DOE/NASA Contract for Wind Turbines

Under a Department of Energy-sponsored program, NASA has selected Rockwell International, Energy Systems Group in Canoga Park, Calif., for contract negotiations for the design, construction, installation, and test of an advanced multi-purpose medium-scale wind turbine system.

NASA is negotiating a cost-shared contract with Rockwell for about $9-11 million for the 350-kilowatt wind turbine system with blades 38 meters in diameter.

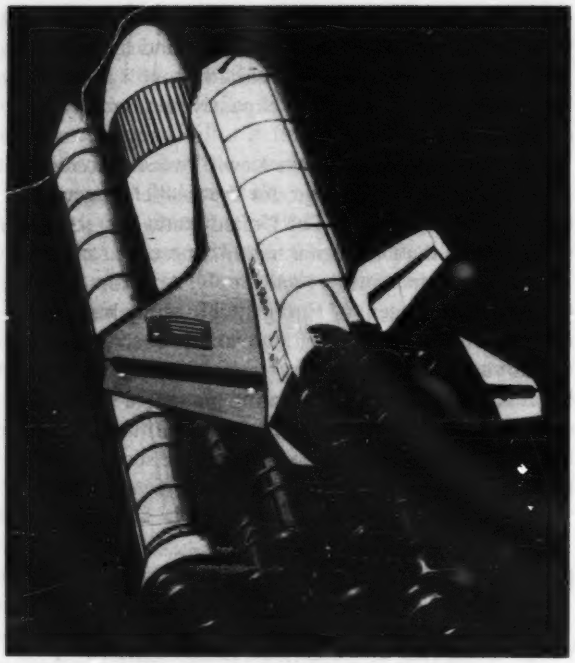
If the program meet its goals and if the machines are produced in quantity, they should generate electricity at costs comparable with that of many conventional power plants when they are installed in moderately windy areas of the country.

The wind turbine will be designed for sites with an annual mean wind speed of 23 kilometers per hour. Sites with such modest winds are relatively common throughout the United States. The wind turbine is scheduled to be built in late 1983 at a site to be selected by the Energy Department.

The test system will be located at a utility company site and will supply electricity to the local electrical system for use by the general public. The purpose of the test system is to evaluate the economics and to test operating characteristics of an advanced medium-scale wind turbine. This project will place special emphasis on developing lower cost wind turbines capable, when produced in quantities of 100 units or more, of providing electricity at a cost less than 6 cents per kw-hour at windy sites.

The experimental wind turbine (the name for modern electrical generating windmills) in part of Energy's program to develop wind energy systems as a supplementary energy source for the nation. NASA Lewis, with expertise in aerodynamics and structures, directs the portion of the Energy Department's wind energy program concerned with medium and large utility-size wind turbine systems.

Lewis is currently operating a 100-kw, 38-m diameter wind turbine test-bed build for Energy at the NASA Plum Brook test area near Sandusky,



Bigger Shuttle Boost—An artist depicts the Space Shuttle configuration with a liquid boost module positioned at the bottom of the external tank and between the twin solid rocket boosters. Marshall Space Flight Center's Shuttle Projects office has been developing such a plan to provide the additional thrust needed for some near polar orbit missions, and two aerospace contractors are now completing program definition studies. With the liquid boost module, Shuttle's payload carrying capability would be increased from 24,000 pounds to about 41,000. Low altitude near polar orbit flights would be launched from Vandenberg Air Force Base, California.

Ohio. This machine is being used to test advanced components and systems which have the potential for improving the performance and reliability of large wind turbines.

Four larger 200-kw versions of this earlier experimental 38-m diameter system are in operation at utility sites located in Clayton, N.M.; Block Island, R.I.; Culebra, Puerto Rico; and Oahu, Hawaii. These machines were assembled and installed by Westinghouse.

A 2000-kw, 61-m diameter machine developed by the General Electric Co. for DOE/NASA is presently being tested and supplying power on the Blue Ridge Electric Cooperative System in Boone, N.C.

A 2500-kw, 91-m diameter experimental machine is being developed by Boeing Engineering and Construction Company for DOE/NASA. Three of these machines are being installed in the first wind turbine cluster at Goodnoe Hills, Wash., on the Bonneville Power System. The first of these will begin operations late this year followed by the other two in 1981.

Two contracts have recently been initiated with Boeing and General Electric each for the design, construction, installation and test of advanced multi-megawatt wind turbines. These machines will be nominal four megawatts each with blades of 91m (300 ft) or more in diameter. The machines are being designed for large power systems at sites with an annual mean wind speed of 14 miles per hour. These wind turbines are scheduled to be built in late 1983 at sites to be selected by the Energy Department.

DOE is also sponsoring the development of wind turbines in various small sizes up to 40 kw. They are designed for residential, agricultural and small industrial users.

Chinese Pose at Ames—A 17-member aeronautics delegation from the People's Republic of China assembled for the group picture with their hosts at Ames Research Center. At center right is ARC Director C. A. Syvertson; to his right is Chinese Vice Premier Bo Yibo. Another Peking delegation also visited NASA Headquarters, and the Lewis, Langley and Dryden centers. The aeronautics experts were invited here by NASA Deputy Administrator Dr. Alan Lovelace, who headed the delegation which traveled to China in June.

Workshop Examines Potential Space Efforts

An orbiting space factory, a self-directed deep-space exploration robot, a fully automated Earth resources and environment monitor and even a lunar base that could grow through self-replication of many of its elements have been examined in a space technology assessment workshop, looking at the next 25 years.

Robotics, artificial intelligence, automation and remotely operated systems are vital to the future of these missions. The enormous benefits of such capabilities at affordable cost has prompted this joint NASA/American Society of Engineering Education summer study at the University of Santa Clara in California.

The 10-week workshop was completed in late August, when an oral report was presented at the University and reports submitted for publication.

The program participants included 18 professors of engineering mathematics and sciences, some 15 NASA engineers and scientists, and a number from interested industrial organizations. The group was drawing on the work of research institutions such as Stanford University, Calif.; Massachusetts Institute of Technology, Cambridge; and Stanford Research Institute in developing computer-based "intelligence" capability.

The workshop was structured to select and define a set of exciting and challenging space missions that would identify critical technology needs for future research and development. As such they are representative of possible future missions rather than specific proposals.

Feasibility analysis has concentrated primarily on four areas:

- A highly versatile "intelligent" satellite information system for most types of Earth survey. Previous systems have suffered from the fact that they record everything they "see," producing huge masses of data.

The proposed information system would do substantial amounts of selection and interpretation of the data coming from its sensors to provide results tailored to the specific needs of the requestor.

In one approach, the system would possess its own world model, stored in a 10-trillion-bit data memory. This would provide reference knowledge of the region of the requested observation.

The satellite would report exceptions to this reference model, such as changes in crop conditions, discarding such well-known phenomena as icebergs, lakes and other landmarks. This would result in a major reduction in the amount of data that must be transmitted and analyzed. The world model would be updated to reflect latest dynamic conditions.

- A second concept is a Deep Space Exploration system to provide reconnaissance, exploration and intensive surface study of planetary bodies.

Specifically, the group is looking at a mission to Saturn's planet-sized satellite, Titan. (Titan has an atmosphere and is bigger than the planet Mercury.) The proposed, self-directed system or robot would combine the functions of several, previously separate missions—orbiter, atmospheric probe and mobile surface-exploration vehicle.

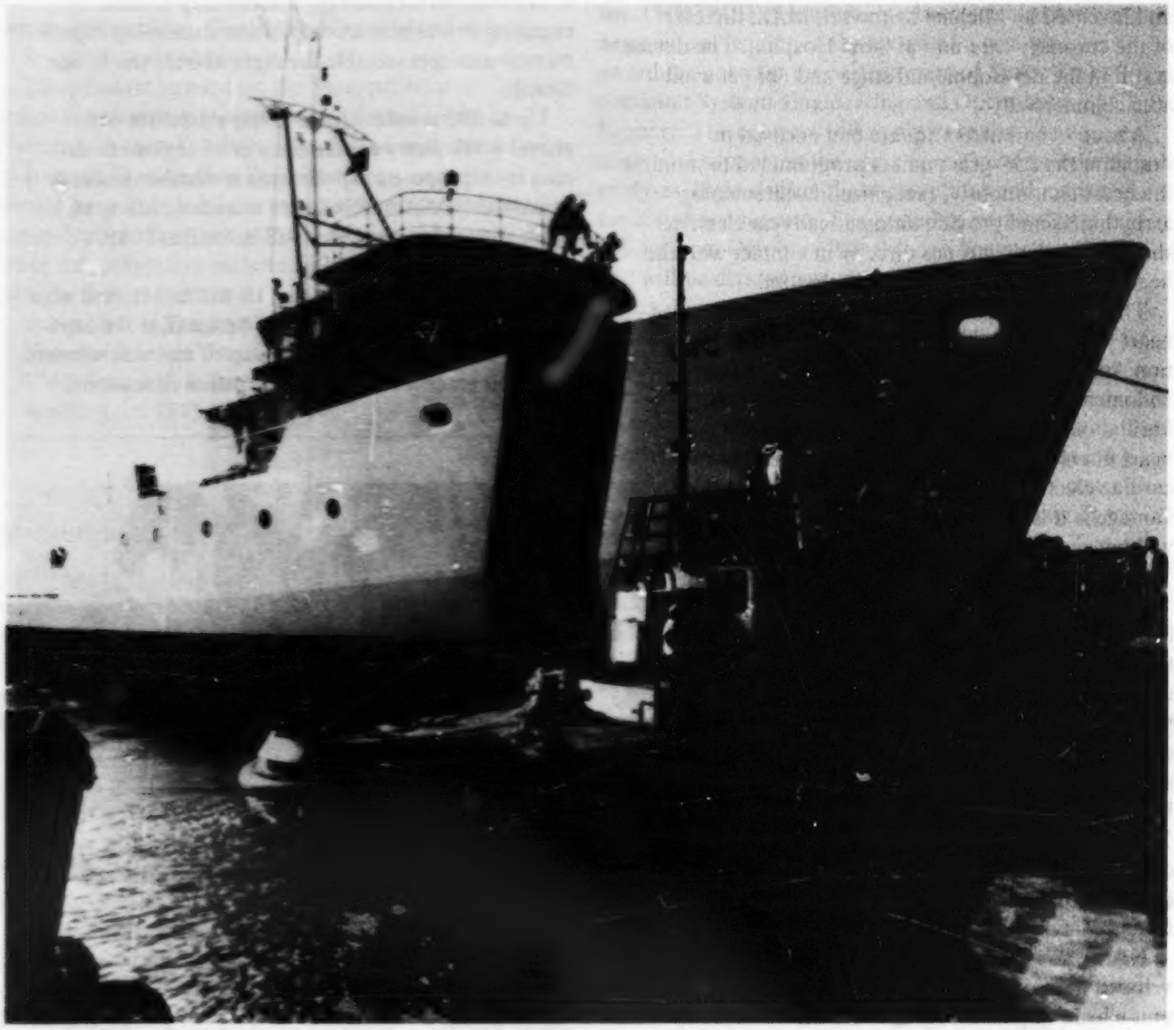
Such self-directed systems could be used to explore distant bodies within the solar system, the outer planets and their satellites, comets and asteroids. It is also the type of system required for the eventual exploration of planetary systems of other stars, where flight and communication times of years, preclude manned involvement and interaction.

- A third area is a facility for use of non-terrestrial materials—from asteroids and moons of Earth and

Low Cost Ingenuity—Keith Clark of the Marshall Space Flight Center demonstrates a small model of the device he invented for handling large metallic structures in space. Basically, the so-called "pneumatically inflatable end effector" is a rubber balloon fed from a compressed air bottle and it is capable of moving lightweight triangular beams. The integral parts of the Clark "end effector" cost 11 cents.

other planets. This would be a permanent, automated Earth-orbiting facility initially using the space environment for unique processing of Earth-supplied raw materials. It would progressively make greater use of non-terrestrial materials. The group is identifying processing and manufacturing techniques well adapted to the space environment. Basic starter facilities are being identified, to be capable of producing a wide range of products and other tools to expand the facility capability.

- Finally, the workshop defined, as an ultimate challenge for advanced automation, a factory on the Moon which would use lunar materials and could replicate itself. One of its first products would be another lunar factory, or factory segment. Such an automated, reprogrammable, self-replicating factory has been of theoretical interest for a number of years, as a way of rapidly expanding utilization of space resources. The workshop has developed proof-of-concept designs and surveyed the types of logical organization for such a factory, and the requirements for an Earth-based demonstration of the concept.



The Shuttle "Navy"—Newest addition to the small fleet that will retrieve the Space Shuttle's solid rocket boosters is the UTC Freedom. It is being fitted out at the Atlantic Marine shipyard, Fort George Island, Florida. The 176-foot-long Freedom is a sister ship to the UTC (United Technologies Corp.) Liberty, launched in the spring. Each of the two ships can retrieve one booster and its associated components and both craft will be used on each Shuttle mission.

Heart Device from Space Technology

The latest of many medical spinoffs developed with space technology is an implantable heart-assist device that could annually prevent thousands of deaths caused by erratic heart action known as ventricular fibrillation.

A pilot study of the device was reported in the *New England Journal of Medicine* by a team of scientists from Sinai Hospital of Baltimore, The Johns Hopkins Medical Institutions and The Johns Hopkins Applied Physics Laboratory. The automated defibrillator—its commercial name is AID—was conceived and invented by Michael Mirowski, M.D., director of the coronary care unit at Sinai Hospital. The device is still in the developmental stage and not yet available commercially.

About 7 centimeters square and encased in titanium, the 255-gram unit is programmed to monitor the heart continuously, recognize life-threatening arrhythmias and provide automatically an electric shock through electrodes directly in contact with the heart to restore the normal heart rhythm.

The device appears similar to the commonly used heart pacemaker but has a markedly different function. Implanted just under the skin in the upper abdomen area in patients subject to ventricular fibrillation—rapid, uncoordinated contraction of heart fibers brought on by grave disturbances in cardiac electrical activity—the device's unique advantage is it is permanently available to the patient without requiring the presence of special personnel or equipment.

Upon implantation, one electrode is affixed to the lower tip of the heart and the second electrode, in the form of a shallow inverted cup, is affixed to the upper border of the heart. The first discharge, or pulse, occurs 15 seconds after the fibrillation begins, to give the heart a chance to correct itself. If the first shock fails to correct the abnormality, three more can be delivered until the heart renews its normal rhythm. The last two shocks, if needed, are of slightly increased intensity. The unit is powered with specially developed lithium batteries having a projected life of three years or 100 shocks.

NASA and Applied Physics Laboratory have developed a monitoring and recording device for the unit which weights 340 grams and can be worn conveniently by the patient. The external recorder monitors the long-term performance of the implanted defibrillator. It is triggered into action by the heart's spasms and stores electrocardiographic data before and after the defibrillator delivers its discharge (shock). It also records the number of fibrillating episodes, pulse applications, the times they occured and the time that elapsed since the last recording.

Space Shuttle Student Project

Rules have been announced for a Space Shuttle student involvement project. a joint venture of NASA and the National Science Teachers Association. The objective of the project is to stimulate the study of science and technology in secondary schools by engaging students in a competition to develop experimental concepts suitable for flight aboard the Space Shuttle.

Up to 200 semifinalists and their teachers will attend preliminary conferences in 10 regions to discuss their proposed experiments with other students as well as NASA and industry scientists. Many of these regional conferences will be held at NASA research centers.

From the 200 semifinalists, 10 will be selected who have developed concepts which best utilize the capabilities of the Space Shuttle These 10 national winners and their teachers will attend a special educational

Gateway to MSFC—James T. Murphy (left), Director of Administration and Program Support at the Marshall center, accepts delivery of the first shipment through the new Huntsville Port of Entry. A U.S. Customs man is handing over Spacelab documentation from West Germany. The airport Port of Entry, just a few miles from the Marshall center, will expedite important shipments to and from the NASA facility.

conference at Kennedy Space Center, Fla., in late summer of 1981. All entrants will receive a certificate of participation.

The Space Shuttle, the world's first reusable spacecraft, is now scheduled for its first manned orbital flight in March 1981. Winning student experiments that are suitable may be performed on flights later in 1981 or 1982.

To announce the formal start of the project, 100,000 four-color posters have been mailed to the nation's secondary schools. Any student is eligible who is regularly enrolled in grades 9 through 12 in U.S. public, private, parochial and overseas schools, including U.S. civil and military overseas establishments, Puerto Rico, Guam, the Virgin Island and U.S. outlying territories.

The contract to conduct the competition and select the winners was awarded by NASA to the National Science Teachers Association, with headquarters in Washington, D.C. Interested students should have their teachers write to the science teachers group for an official entry form, rules booklet and other supplementary material. Teachers should address their request to:

Space Shuttle Program
National Science Teachers Association
1742 Connecticut Avenue, NW
Washington, D.C. 20009

McCormick to Air Force Post

Robert J. McCormick, Executive Officer at NASA since September 1977, was selected as Administrative Assistant to Secretary of the Air Force Hans Mark in August.

McCormick joined NASA in January 1976 after a long career in the Air Force, including assignments in Japan, Korea, France, Vietnam and the United States. His last 10 years were spent in research and development program management and he retired as a Colonel in July 1975. In his new position, he will be responsible for administrative support activities for the office of the Secretary of the Air Force.

A native of Boone, Iowa, McCormick received his bachelor's degree in mechanical engineering and did graduate work at Texas Technological University, Lubbock.

Married to the former Shirley Zerbe of Phoenix, the couple have five children and make their home in Fairfax, Va.

Contractor News

EDG Engineering Incorporated, Houston, has received a $13 million contract from the Lewis Research Center for modernization of the facility's central air system. The 39-month fixed-price contract is effective immediately and work will be performed at the Lewis center and the contractor's Houston plant. EDG Engineering will design, fabricate hardware and software, and install a centrally located control and data acquisition system using modern control and computer technology.

McDonnell Douglas Technical Services Company, Inc. (MDTSCO), Houston, has been selected for negotiations leading to the award of a cost-plus-award-fee contract for performance of Space Transportation Systems Engineering and Operations Support. The contract will apply to technical and analytical support in the areas of engineering systems analyses, flight design, flight operations and management systems support. The period of performance will be from October 1980 through September 1986 and will be divided into three equal contract increments. Management and technical direction will be under the Johnson Space Center and the contractor's estimated cost for the first two-year increment plus a firm two-year option is $25 million.

Aerospace Services Division of Pan American World Airways, Inc., of Cocoa Beach, Fla., has reached agreement on a year's extension of its contract to supply medical services at the Kennedy Space Center and Cape Canaveral Air Force Station. The $2 million award marks the fourth year of service under the contract, providing occupational medicine and environmental health care to civil service, military and contractor personnel.

Rocketdyne Division of Rockwell International Corporation, Canoga Park, Calif., has been awarded a letter contract for materials for six first stage engines in the three stage Delta space vehicle. Value of the contract approximates $4 million, which will be negotiated as a fixed-price incentive agreement.

Boeing Services International, Inc., of Seattle, has agreed to a one-year extension of contract with the Kennedy Space Center for ground systems operations. The contract value is placed at over $49 million. Under its terms, BSI will provide facility and utility operations and maintenance, including propellants, cranes, doors and platforms, elevators, service shops, nondestructive evaluation, life support and industrial operations.

Did You Know?

The European Space Agency has approved a project to send a spacecraft to Halley's comet in this decade. ESA's exploratory mission, bearing the name of Giotto, involves a spacecraft flying to the comet in 1986 at a speed of 70 kilometers a second. The European craft will have a payload consisting mainly of a camera and mass spectrometers for measuring the atomic composition of the target. The mission takes its name from the "Adoration of the Magi" scene in the fresco by Giotto di Bondone, now in the Arena Chapel in Padua, with the comet depicted in the sky background. Halley's comet enters the inner part of the solar system about every 76 years.

NASA Lewis Research Center has won three awards in Industrial Research and Development Magazine's annual national competition, which recognizes the 100 most significant new technical products developed during the past year. The honor is nothing new for Lewis; since the competition began in 1963, the NASA center has won 32 of the awards, sixth best showing among the leading all-time winners.

The Safety Office of the Marshall Space Flight Center, with the endorsement of Center Director W. R. Lucas, this year set out to make 1980 the safest one ever for the Alabama facility. By August 6, Marshall had set a record for its 20-year history—two million manhours worked without a lost-time injury. By the end of August, the figure was even higher—2,450,766.

The Eastern Shore of Virginia is the setting for NASA's newest visitors center, slated for Route 175 adjacent to the Wallops Flight Center airport. A contract was awarded the Taylor Construction Company, Parksley, Virginia, in July and scheduled completion of the building is within 210 calendar days (7 months). The Wallops facility will provide an educational outlet for schools and a theatre for films and exhibits.

Idea Clearinghouse this month acknowledges the good work of the Computer Services Office at the Marshall center. With its improved input processing function, the number of jobs processed has greatly increased and more time is available to center engineers. The office found a solution to the slow batch mode processing system, allowing individual users to key their data through interactive terminals, both printer and graphic types. The user can communicate directly with MSFC's U-1108 computer with a response time of minutes instead of hours or days. Marshall's Charles Houston has the story at (FTS) 8-872-2364.

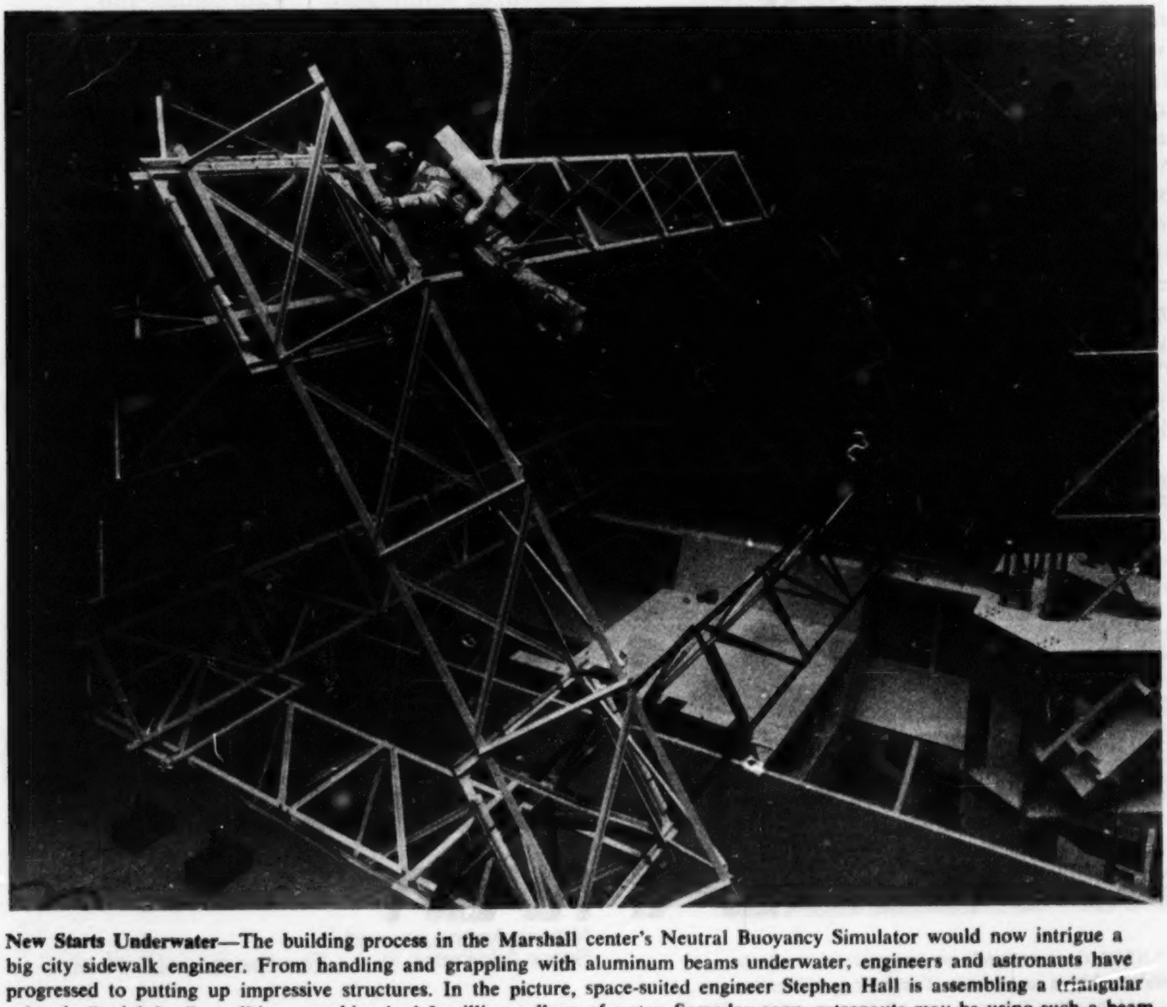
Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No	Installation
William C. Ruehr, James L. Younghans, Edwin B. Smith, G. E. Company, Cincinnati	Curved centerline air intake for gas turbine engine	4,220,171	LeRC
Joseph T. Bloch, Randolph T. Hanger, Frank W. Nichols, Boeing Aerospace Co., Seattle	Method and apparatus for fabricating improved solar cell modules	4,219,926 4,221,005	NRO/JPL JSC
David T. LaFlame, Hughes Aircraft Company, Los Angeles	Pseudonoise code tracking loop		
Satoshi Nagano, Caltech/JPL, Pasadena	Improved base drive for paralleled invertor system	4,222,098	NRO/JPL
Ralph V. Sawyer, Bill Szuwalski, NASA/Dryden	Computer circuit card puller	4,224,810	DFRC
Dhanvada M. Rao, Old Dominion University Research Center, Norfolk	Aerodynamic side-force alleviator means	4,225,102	LaRC
Jack A. Kinzler, James T. Heffernan, Leroy G. Fehrenkamp, NASA/Johnson	Surface finishing	4,225,372	JSC

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January 17	Atlas Centaur	ESMC	DOD Navy. Reimbursable.
SMM-A	February 14	Delta	ESMC	NASA. Scientific Solar Maximum Mission.
NOAA-B	May 29	Atlas-F	WSMC	NOAA Weather. Reimbursable. Launch vehicle failed.
GOES-D	September 9	Delta	ESMC	NOAA Weather. Reimbursable.
FLTSATCOM-D	October	Atlas Centaur	ESMC	DOD Navy. Reimbursable.
SBS-A	November	Delta	ESMC	Satellite business systems. Reimbursable.
Navy 20	November	Scout	WSMC	DOD Transit. Reimbursable.
Intelsat V-A	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.



New Starts Underwater—The building process in the Marshall center's Neutral Buoyancy Simulator would now intrigue a big city sidewalk engineer. From handling and grappling with aluminum beams underwater, engineers and astronauts have progressed to putting up impressive structures. In the picture, space-suited engineer Stephen Hall is assembling a triangular prism in "weightless" conditions, working in 1.3 million gallons of water. Someday soon, astronauts may be using such a beam machine carried aboard the Space Shuttle to establish large, beamed complexes in orbit.

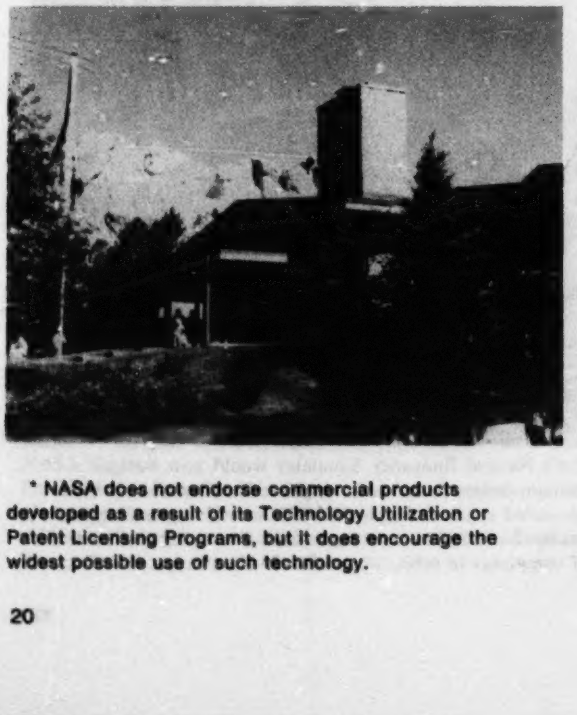
Another Dividend from Air and Space

Research and development in aeronautic and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Solar Heat and History

Below the familiar pantheon of great Americans at Mount Rushmore, South Dakota, is a rustic visitors center. It is now a solar-powered facility, one of more than 100 such buildings managed by NASA's Marshall Space Flight Center for the Department of Energy's National Solar Heating and Cooling Demonstration Project. Aim of the program is to promote national energy conservation by stimulating interest in solar energy as an alternative to fossil fuels. The Mount Rushmore installation employs 112 individual collectors, which are smaller than some of the other Marshall-managed fixtures and are flat plates rather than concave. They supply more than half the visitors building's heating and hot water needs and about 40 percent of the cooling requirement. Lennox Industries, Marshalltown, Iowa, produced the Mount Rushmore collectors.*

The Marshall center's role in the National Solar Heating and Cooling Demonstration Project is that of supervisor and technical advisor for a variety of demonstrations in such places as industrial plants, office buildings, schools, museums, libraries and private homes. The center lends its broad solar energy expertise to handling contract negotiations, reviewing designs and overseeing construction. A major Marshall responsibility is monitoring solar equipment performance. Sensors installed by the center's engineers take frequent data samplings at each site. The information is stored on tape and relayed once a day to a central processing facility at MSFC's Huntsville, Alabama, headquarters. There it is analyzed and evaluated to determine the effectiveness of the various types of solar equipment being used in different parts of the country. The process is continuous and conducive to advanced solar energy systems of the future.



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National Aeronautics and Space Administration

For the benefit of all . . .

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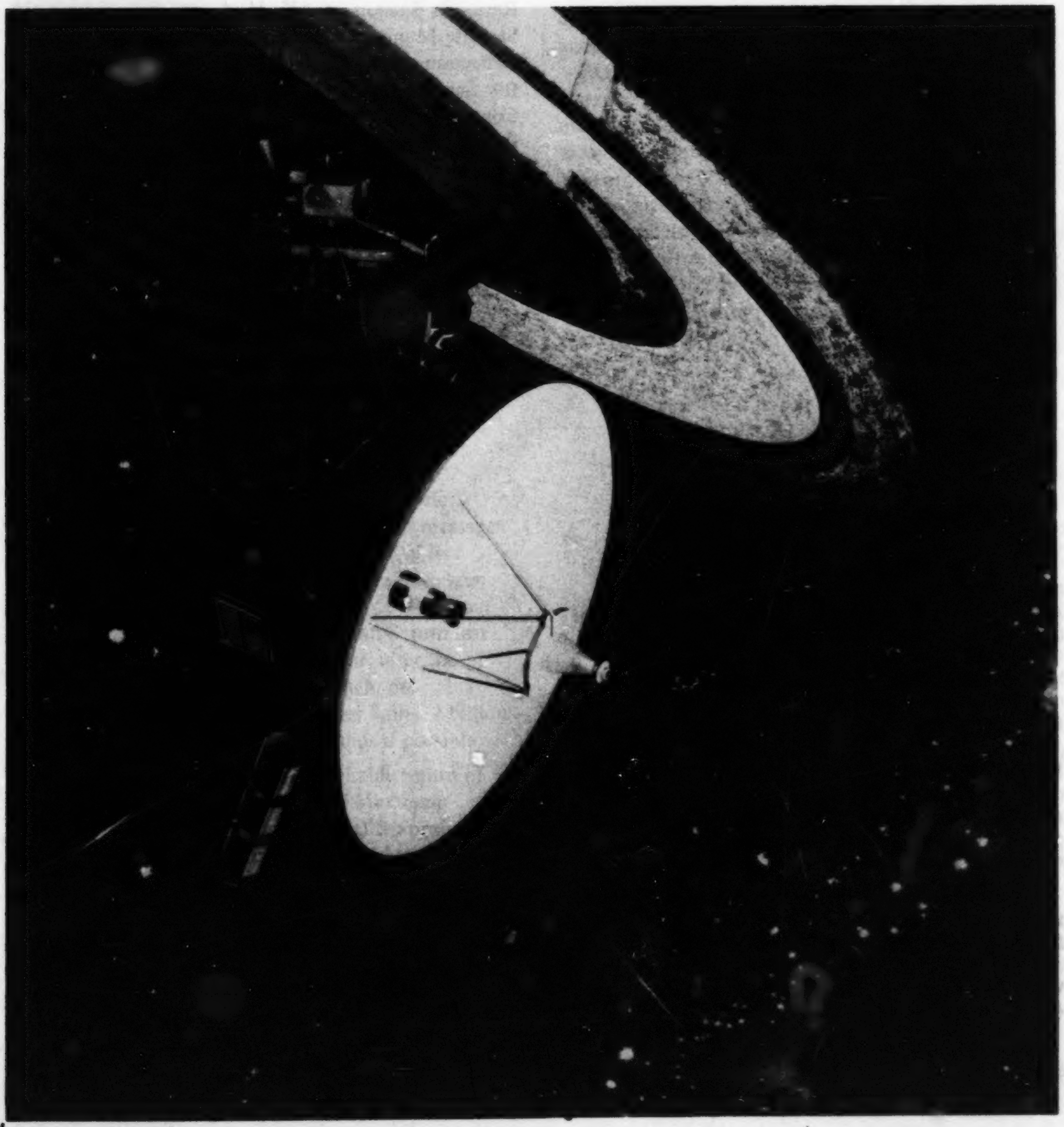

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COVER

Multibillion Miles Away—As an artist sees it, Voyager 1 passes beneath the rings of Saturn after the encounter on November 12. Voyager 2, at this point, was nine months behind and speeding toward its rendezvous with Saturn in August 1981. When Voyager 1 made its flyby of the ringed planet, it had traveled more than 2 billion kilometers since launch.

The twin spacecraft, after completing their planetary missions, will search for the outer limit of the solar wind—that presumed boundary somewhere in our part of the Milky Way where the influence of the Sun gives way to that of other stars of the galaxy. If all goes as planned, Voyager will target on far Uranus in 1986.

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Letter from Washington

Dear Colleagues:

This will be my last holiday season as NASA Administrator, and I again convey my thanks for all the support and selfless good will that the people of this agency have shown me. I take with me not only appreciation, but an abiding respect for a government work force that is the epitome of professionalism. Years of experience usually do provide a certain competence in this government service, but a true professional carries it farther. Besides knowing his or her job, the NASA employee is motivated far above the normal by a firm knowledge of the *importance* of this work. We are accomplishing things never done before in science and high technology, engineering, in aeronautics, medicine and in improving the very quality of life. At NASA, this is a shared conviction and it serves to set this agency apart.

The year that is closing out has been historic. That is a statement traditional in Christmas messages and in the case of NASA, in every decade of its existence, especially true. Every year, we have seen goals met and achievements realized totally without precedent. The Voyager encounter with Saturn last month is just the beginning. Next year, after the sister spacecraft has made its approach, the Voyagers will proceed on to the outer limits, 2 billion miles from Earth, and a visit to Uranus if possible.

Nineteen-eighty has seen a remarkable return of pictures and information from Solar Maximum Mission; the Space Telescope and Galileo projects are proceeding well, promising a valuable schedule of exploration in deep space through the rest of the decade. Mars and the Viking expeditions there have opened the way to further automated investigations. VOIR, and the unveiling of Venus, lies ahead.

The Space Shuttle holds the key to further missions. In three short months, in the culmination of intensive preparation and hard work, Pad 39A at the Kennedy Center will tremble to the roar of Columbia's departure. The Space Transportation System will be launched with the first orbital test flight and the way will be open to man's permanence in space. It will mark a giant step in world communications and it will place us in a new position to do orbital research. Construction and structures in space are sure to follow as we leave our planet routinely and at will. The Space Shuttle is the means to "technological revolution". H. G. Wells said once of space and its promise, "the choice is the universe or nothing." I know that NASA has accepted that challenge and is proceeding with all its knowledge and determination to meet it.

My tenure here has been an education as well as a service; I have learned what tangible benefits to mankind NASA provides today. I will follow with unstinting admiration your triumphs in the future. You are the opposition to the spectre of a closed society with limited resources on Earth. Your professionalism and belief in yourselves will carry us to better horizons. Whether there is extraterrestrial intelligence already out there or not, we are embarked on creating extraterrestrial intelligence: ourselves.

Sincerely,

Robert A. Frosch

Voyager Takes Close Look at Saturn

In what has been called the greatest mission of planetary discovery, marking the third episode in a decade-long, multibillion-mile space odyssey to the outer planets and beyond. Voyager encountered the ringed planet on Nov. 12, making its closest approach at approximately 6:45 p.m. EST at a distance of 124,200 kilometers from the visible cloud tops.

The flyby of Saturn came more than 20 months after Voyager's close approach to Jupiter in March 1979, and 16 months after a sister craft, Voyager 2, made its Jovian encountered in July 1979.

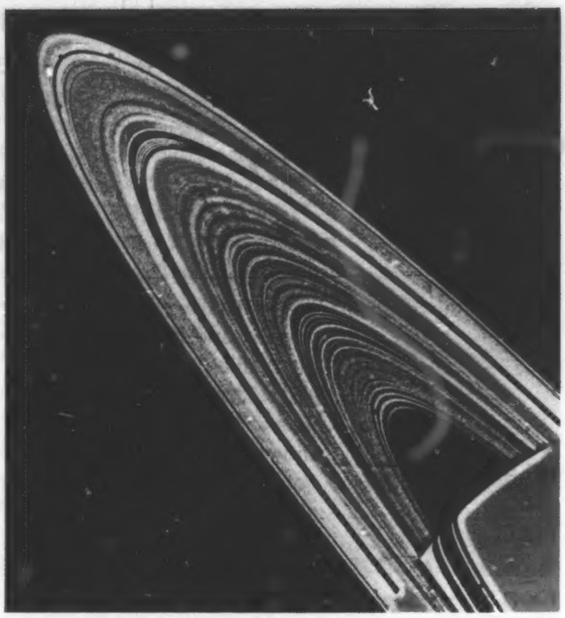
Voyager 1's detailed scientific examination of Saturn, its rings and moons, is the NASA spacecraft's final planetary encounter before it leaves the solar system about 1990. Voyager 2 will encounter Saturn later next year, followed by possible Uranus and Neptune encounters in 1986 and 1989 respectively.

The closeup looks at the outer planets are the most current steps in the United States program of systematic planetary exploration, in which the solar system is used as a natural laboratory. By being able to compare the similarities and differences of the various planets, scientists hope to learn more about the history and future of the solar system and particularly our own planet Earth. The outer planets, evolving at a different rate and under different conditions than the inner planets—Mercury, Venus and Mars—play a particularly important role in this effort.

A prime target for study by Voyager 1 was Saturn's satellite Titan, the large moon in the solar system now known to have an extremely cold, nitrogen atmosphere. The spacecraft approached Titan at a distance of 4,000 km from the surface, the closest approach to any body in the Voyager mission, on Nov. 12 at 12:41 a.m. EST (spacecraft time).

The same day, Voyager also made its closest approach to Saturn and the satellites Tethys (415,320 km) at 5.16 p.m. EST; Mimas (88,820 km) at 8:42 p.m.; Enceladus (202,521 km) at 8:50 p.m.; and Dione (161,131 km) at 10:39 p.m. Closest approach to Rhea (72,000 km) was at 1:21 a.m. EST on Nov. 13.

When the two Voyager spacecraft have completed their television experiments they will have sent more than 70,000 pictures of Jupiter, Saturn and its rings, 13 satellites and black space near the two planets. Black-space imaging at Jupiter resulted in discovery of one its three newly found moons.



Saturnian Ring Scrutiny—This computer composite of four Voyager 1 photos contains a wealth of new information on the rings of Saturn, including subtle color variations and startling "braided" rings. Voyager took the pictures in November from 8 million kilometers away and they were combined and enhanced in the Image Processing Lab at Jet Propulsion Laboratory. Portions of all of Saturn's rings can be seen: small arc-shaped feature is part of the F-ring. Next inward is the A-ring, split by the dark Enke Division. Dark region between A-ring and B-ring is Cassini Division, filled with material discovered by Voyager 1. Innermost ring visible is the C-ring, each of the planet's four main rings appears to be composed of several finer rings.

At Saturn, as at Jupiter, Voyager's radio signals were used extensively to measure the atmospheres of the planet and satellites and assess the size and density of the ring particles.

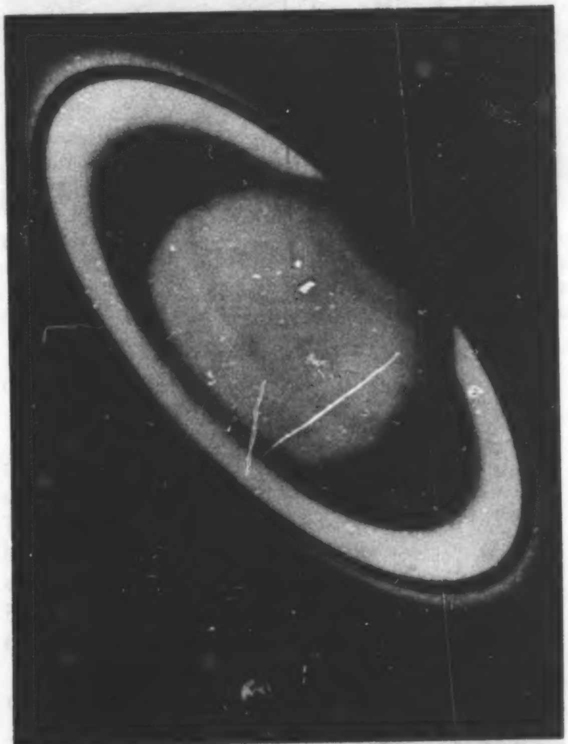
The Voyager 1 trajectory includes occultations of the Earth and Sun by Titan, Saturn and the rings, During these three occultations, Earth is eclipsed by Titan, Saturn and the rings from the spacecraft's point of view. As Voyager passes behind each body, its radio signals pass through the atmospheres of Saturn and Titan and through the rings toward Earth; resultant changes in the radio signals will provide information on characteristics of the planet's and satellite's atmospheres, ionospheres and the size and density of ring particles.

Each Voyager uses 10 instruments and the spacecraft radio system to study the planets, their principal satellites, Saturn's rings, the magnetic and radiation regions surrounding the planets, and the interplanetary medium. (The photopolarimeter on Voyager 1 had failed and was not used at Saturn; the one on Voyager 2 is still operating.)

The Voyagers are carrying telescope-equipped television cameras, cosmic ray detectors, infrared spectrometers and radiometers, low-energy charged-particle detectors, magnetometers, photopolarimeters, planetary radio astronomy receivers, plasma detectors, plasma wave instruments and ultraviolet spectrometers.

The spacecraft began the observatory phase of its encounter on Aug. 22 and will conclude the 117-day surveillance of the Saturnian system on Dec. 15.

Voyager 2 will follow its sister spacecraft to Saturn in August 1981. Its possible four-planet itinerary includes encounters with Uranus in January 1986 and Neptune in August 1989.



Planetary Comparison—The size of Saturn and the Earth are shown in this photograph synthesizing separate pictures. The diameter of the ringed planet is 126,400 kilometers, ten times that of Earth; more than 300 Earths could fit into the volume of the other. At the same time, Saturn has such little density that the whole planet could float in an ocean, if there were one large enough to hold it.

Saturn is the sixth planet from the Sun, second largest in the solar system. Like Jupiter, it is a giant sphere of gas—mostly hydrogen and helium with a small core of rocky material. The planet takes 29.46 years to complete one orbit around the Sun, which is approximately 1.42 billion km away. A day on Saturn lasts 10 hours, 39 minutes, 24 seconds.

Until recently, Saturn was believed to be the only planet encircled by rings. But both Jupiter and Uranus were discovered to have thin, barely visible rings. (The Jovian ring was discovered by Voyager.) Saturn's rings, however, are much richer in material, probably chunks of ice and dirt, and are bright and highly visible from Earth-based telescopes.

At least six rings surround Saturn. From the planet outward, they are designated D, C, B, A, F and E. Divisions between the rings are believed to be caused by the three innermost satellites, Mimas, Enceladus and Tethys. The Cassini Division, a space between the B and the A ring, is the only division clearly visible with a small telescope from Earth.

The Encke Division is a small gap in the rings. The Pioneer spacecraft, which flew past Saturn in September 1979, detected a gap between the A and F rings. Pioneer also reported a third division between the C and B rings.

Saturn's face, in comparison to Jupiter's, is bland and tranquil in appearance. This may be due to thick, high-altitude haze that gives Saturn its opaque appearance, hiding weather activity in the planet's atmosphere.

Saturn has at least 13 satellites, though many more not yet discovered may orbit the planet. The existence of 10 has been known for some time and these objects have been named; of the three recently discovered satellites, two appear to share the orbit of Dione and one of Enceladus. From the planet outward, the 10 named satellites are Janus (whose existence is now doubtful), Mimas, Enceladus, Tethys, Dione, Rhea, Titan, Hyperion, Iapetus and Phobe.

In its excursion though the Jovian system, Voyager 1 discovered a wispy ring of particles around Jupiter and towering volcanoes on Io. Superbolts of lightning and immense auroras were found in the planet's violently churning atmosphere.

More than 18,000 pictures of Jupiter, the four Galiliean satellites—Io, Europa, Ganymede and Callisto—and tiny Amalthea were obtained with

Voyager 1's two-camera imaging system during the 98-day encounter. Voyager 2's visit to the Jovian system yielded an additional 15,000 pictures of the giant planet and its satellites.

Using Jupiter's enormous gravity, the two spacecraft were hurled onto trajectories toward Saturn. When Pioneer 10 and 11 passed through Jupiter's intense radiation in their 1973 and 1974 encounters, the two Voyagers were still being assembled. Based on data from the Pioneers, some Voyager parts were exchanged for more radiation-resistant components, electronic circuits were modified, and additional radiation shielding was added to each spacecraft. As a result, the Voyagers suffered little damage in their flybys of Jupiter.

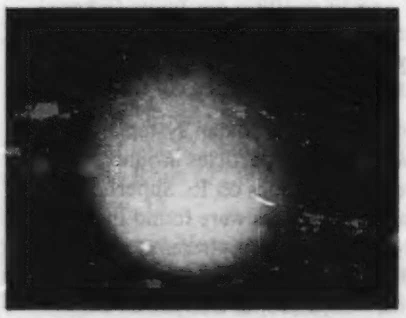
Saturn's radiation is much gentler than Jupiter's. When Pioneer 11 flew beneath Saturn's rings, radiation intensity dropped dramatically, showing that charged particles are interrupted and absorbed by particles in the rings.

Voyager 2 was launched Aug. 20, 1977, from Cape Canaveral, Fla., aboard a Titan Centaur rocket. Two weeks later, on Sept. 5, Voyager 1 was launched on a faster, shorter trajectory and sped past its twin before the end of the year. By the time Voyager 1 reaches Saturn, Voyager 2 will be nine months behind.

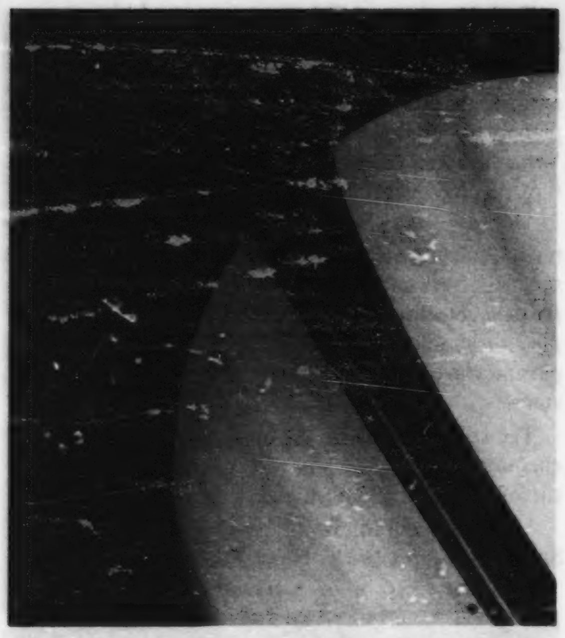
When Voyager 1 encountered Saturn it had traveled more than 2 billion km (1.24 billion mi.) since launch.

The Voyager Project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, Calif., a government-owned facility, operated for the space agency by the California Institute of Technology.

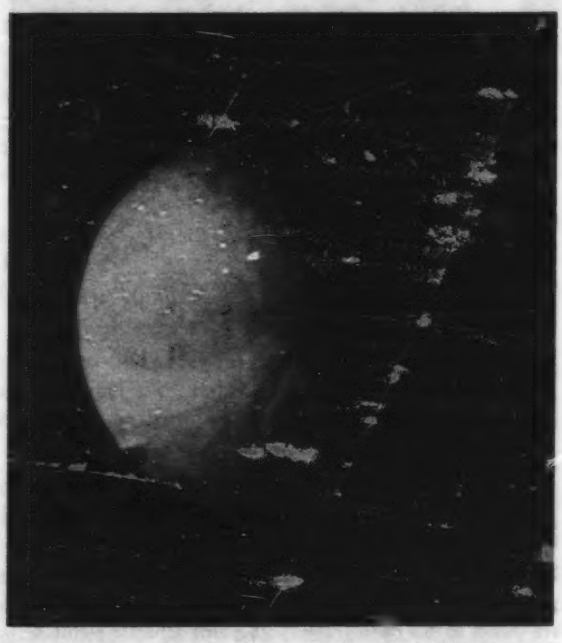
NASA program manager is Frank A. Carr, and Dr. Milton A. Mitz is NASA program scientist. Voyager project manager is Raymond L. Heacock, JPL, and Dr. Edward C. Stone of Caltech is project scientist.



Titan, the large satellite, under heavy cloud cover.



Moons Over Saturn—Two of the planet's 15 or more moons—Tethys and Dione—were photographed on November 3. The shadows of Saturn's three brightest rings and Tethys are cast onto the cloud tops.



Encounter Day—The heavily cratered surface of Tethys was photographed from a distance of 1.2 million kilometers on November 12. This face of Tethys looks toward Saturn and shows a large valley about 750 km long, a fracture of unknown origin.

Thumbs Up for March—The Space Shuttle first team gives the signal for success during a power up mission simulation in the orbiter Columbia. John Young, commander, in the left hand seat, and pilot Robert Crippen are the prime astronaut crew for the first orbital test flight in March 1981. The schedule is holding and Columbia was rolled out from the Kennedy center's Orbiter Processing Facility in November. The intensive preparation period for launch is now underway.

"Rollover"

Holding to schedule, the Space Shuttle orbiter was rolled over from its processing hanger to the Kennedy center's Vehicle Assembly Building on November 24. The "rollover" went without a hitch and now safely in the VAC, the Columbia will be wedded to its external fuel tank and two solid rocket boosters. The last of over 30 thousand thermal protection tiles will be attached in place.

If all goes well, rollout will take place the day after Christmas. The Shuttle will be moved to launch pad 39A for the remaining weeks of on-pad testing. Testing of the main Shuttle engines should be completed by January, despite a setback in early November, when three engines shut down prematurely at the NSTL test site.

Shuttle Engine Nozzle Tested

Engineers at the Marshall Space Flight Center have completed a series of vibration tests on a modified nozzle for the Space Shuttle's main engine. The tests were designed to determine if modifications to hydrogen lines on the nozzle will enable the lines to better withstand certain potentially damaging vibrations they will encounter during engine operations. While the resulting data has not yet been fully analyzed, preliminary results look good, according to Garland Johnston, Chief of the Dynamics Test Branch of Marshall's Test Laboratory.

The investigation involved the nozzle's "downcomer" and "steerhorn" lines. The downcomer is a tube which carries super-cooled liquid hydrogen fuel down the outside of the nozzle from the engine's high pressure hydrogen turbopump, and the steerhorn line, named for its shape, distributes the hydrogen to a coolant inlet manifold which encircles the base of the nozzle. The hydrogen then flows upward through a network of smaller tubes to cool the nozzle and preheat the hydrogen fuel for combustion. There are three sets of downcomer and steerhorn lines on each nozzle.

A steerhorn line failed during a test of the Shuttle's main propulsion system in November 1979 and subsequent evaluation determined that certain vibrations generated by the engine contributed to the failure. During those evaluations it was learned that some frequencies caused the steerhorn and downcomer feedlines to move about excessively, placing high stress on weld joints.

To strengthen them against this stress, the steerhorn weld joints on the Columbia's flight engines, and the engines in the Shuttle's Main Propulsion Test Article, have been nickle plated. Permanent modifications for engine nozzles to be used on future Shuttle flights include an increase in the number of places at which the steerhorn is attached to the nozzle and the attachment of the downcomer at the top of the nozzle. Another modification which has helped reduce stress at critical points was the addition of a "steam loop" to the downcomer. This addition was made to allow for the expansion of the line due to the additional attach points, but the loop or bend in the line also acts as a soft spring to help damp out the damaging motions.

Payload Truck—Resembling an outsize covered wagon, the Space Shuttle Canister and Transporter are mated near the Kennedy center's Vehicle Assembly Building. The combination will handle and transport Shuttle payloads throughout KSC. The Canister restrains and environmentally protects the payloads in transit while the 48-wheel Transporter can move in any direction, under both diesel and electric power.

Fourth FLTSATCOM Launched

The fourth of five FLTSATCOM communications satellites was launched from the Kennedy Space Center on Oct. 30. The Department of Defense satellite went into service over the western Pacific Ocean.

FLTSATCOM-D was placed in a geostationary orbit at 172 degrees east longitude above the equator, where it will provide two-way communications in the 240 to 400 MHz frequency band, between any two points on Earth visible from its orbital location. The spacecraft has a design life of five years.

The FLTSATCOM program is managed by the Naval Electronic Systems Command. The Air Force Space Division is responsible for production, launch vehicle/spacecraft integration and tracking and data acquisition.

The FLTSATCOM satellites are the spaceborne portion of a worldwide Navy, Air Force and Department of Defense system to enable communications between naval aircraft, ships, submarines, ground stations, Strategic Air Command elements and presidential command networks. The satellite system will provide 23 ultra high frequency communication channels and one super high frequency channel.

This was the 53rd launch of an Atlas Centaur, NASA's standard launch vehicle for intermediate-weight payloads. The first Atlas Centaus was launched May 8, 1962.

NASA is reimbursed for all additive costs of the Atlas Centaur and launch services by the Department of Defense under provisions of a launch services agreement.

The Atlas Centaur (AC-57) launch vehicle placed FLTSATCOM-D into a highly elliptical orbit of 167 by 35,970 kilometers. After reorientation of the satellite, a solid propellant rocket motor aboard the spacecraft was fired to circularize the orbit at a synchronous altitude of 38,788 km. At that altitude, because the speed of the spacecraft in orbit matches the rotational speed of the Earth, the satellite remains in position over one spot on the equator.

NASA's Lewis Research Center, Cleveland, has management responsibility for the Atlas Centaur development and operation. NASA's Kennedy Space Center, Fla., is assigned vehicle checkout and launch responsibility once the vehicle reaches Cape Canaveral.

Mars Photo Book Published

All but one of the four Viking spacecraft sent to explore Mars are silent now, but they have left a legacy of hundreds of remarkable photographs of the Red Planet.

Some of the best of these pictures are included in a new NASA paperback publication entitled "Images of Mars: The Viking Extended Mission." Collected by Nancy Evans of the Jet Propulsion Laboratory, Pasadena, Calif., and Michael H. Carr of the U.S. Geological Survey, the pictures illustrate the varied landscape of one of the Earth's closest planetary neighbors.

The boulders of Mars are shown in the NASA photo book

The Viking spacecraft, launched in 1975, reached Mars in 1976 and transmitted back to Earth hundreds of photos of the Martian surface from orbit as well as from the surface itself. The 30 black and white photographs in "Images," some as recent as 1979, were selected not just for their visual impact, but for what they tell the viewer about the terrain they depict.

Soaring volcanoes, mysterious channels, tremendous chasms that could swallow the Grand Canyon, rocks, boulders and sand—all are shown in great clarity. The notes accompanying each photograph explain, in layman's terms, what each image shows.

This armchair guide to Mars was produced by NASA's Scientific and Technical Branch. NASA SP-444 is available for $2.25 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

LaRC Ribbon-Cutting—The new steam generating plant opens at the Langley center as a foursome makes it official. From the left, Air Force Brig. Gen. W. Troy Tolbert, NASA Administrator Dr. Robert A. Frosh, City of Hampton Mayor Thomas J. Gear, and Sen. John W. Warner, R-Va. The refuse-fired plant became operational in November.

Refuse-Burning Plant Dedicated

A refuse-fired steam generating plant in Hampton, Va. was dedicated on Oct. 9, at the site on Wythe Creek Road, next to the NASA Langley Research Center Impact Dynamics Research Facility.

U.S. Senator John W. Warner, R-Va., gave the principal address during the dedication ceremony for the $10.4 million facility which transforms refuse into energy.

Others attending included Dr. Robert A. Frosch, NASA Administrator; Billie J. McGarvey, NASA Headquarters Facility Division Director; Brig. Gen. W. Troy Tolbert, Commander, First Tactical Fighter Wing, Langley Air Force Base; Thomas J. Gear, Mayor of the City of Hampton; and other NASA, Air Force and Hampton City officials.

The plant, funded by NASA, the City of Hampton and the U.S. Air Force, will operate 24 hours a day, seven days a week. The plant's systems are now being tested and officials hope to have the facility fully operational in November.

Standard household refuse, such as paper and food waste, from the City of Hampton, the Langley Research Center, Langley Air Force Base, Fort

Monroe and the Veterans Administration will be burned at the plant.

Odors from the refuse will be dissipated inside the facility and the gases which are expelled through the smoke stacks will meet or exceed state and federal environmental protection regulations.

The plant, which is on NASA property, will be leased to and operated by the City of Hampton. The steam will be sold to NASA Langley for heating and cooling its facilities. The program originated during NASA Langley studies regarding energy conservation projects to improve the community's environment.

The plant will:

- Greatly extend the life of Hampton's sanitary landfill, and eliminate the area's federal sanitary landfill.
- Improve the environment by providing a more acceptable means of refuse disposal.
- Reduce the City of Hampton's refuse disposal cost through the sale of energy, produced by the plant, to NASA Langley.
- Save about two million gallons each year of fuel oil, now being bought by the center for its steam system.

The process of using refuse to produce steam follows a relatively simple procedure.

A truck loaded with refuse drives on the plant's tipping floor and drops its load into a refuse pit, which has a capacity of 600 to 800 tons.

A crane then picks up the refuse and drops it through a chute; at the bottom of the chute the refuse is pushed into a furnace.

The heart of the refuse-burning plant is two water-walled boilers that reduce solid waste to ash through incineration in the furnace.

As the refuse is burned, the ash falls out of the boilers on to conveyors. It is then transported to the city landfill. The volume of the ash will amount to only about one-seventh of the solid refuse brought to the plant.

The water that flows through the walls of the boiler is converted into steam to heat or cool the facilities at Langley. About 300 million pounds of steam will be produced each year. The gases in the boiler exist through an electrostatic precipitator, which cleans the gases before they are expelled into the atmosphere.

MSFL Begins Gravity Probe

Dr. Alice K. Neighbors

Dr. W. R. Lucas, director of the Marshall Space Flight Center, has established a Gravity Probe B(GP-B) Task Team within the Program Development Directorate. Dr. Alice (Joyce) K. Neighbors was named manager and Joseph C. Cody was designated chief engineer.

The GP-B is a proposed space science mission requiring sophisticated flight experiment hardware and the application of advance technology. The Earth orbital spacecraft will contain a gyro-relativity experiment which will be used to test the general theory of relativity and provide data to resolve conflicting gravitation theories.

The primary function of Dr. Neighbors' team will be to promote the focus and thrust for the planning, implementation and accomplishment of a comprehensive in-house preliminary design and definition effort for the GP-B.

Kerrebrock to Head Aeronautics

Dr. Jack L. Kerrebrock of the Department of Aeronautics and Astronautics at Massachusetts Institute of Technology, has been named Associate Administrator for Aeronautics and Space Technology at NASA Headquarters, effective June 1, 1981. He will be responsible for NASA's aeronautics, space and energy research and technology programs.

Kerrebrock has taught and conducted research in energy conversion and propulsion since 1956 when he received his Ph.D. degree from California Institute of Technology. He received his B.S. degree from Oregon State University in 1950 and his M.S. from Yale in 1951. He was an aeronautical research scientist at Lewis Research Center, Cleveland, of the National Advisory Committee on Aeronautics, from 1951 to 1953.

His early work was on nuclear rockets, space propulsion and power, and magnetohydrodynamic generators. More recently, he has been involved with the fluid mechanics of turbomachinery for aircraft engines, and is the author of a text on aircraft engines and gas turbines. He was the director of the M.I.T. Gas Turbine Laboratory from 1968 to 1978 and is the first to hold the Richard Cockburn MacLaurin Professor of Aeronautics and Astronautics, established in memory of M.I.T.'s sixth and youngest president.

Kerrebrock replaces Dr. James J. Kramer who retired in October 1979. Dr. Walter B. Olstad, the Office of Aeronautics and Space Technology Deputy Associate Administrator, will continue to serve as Acting Associate Administrator for the interim period prior to June 1981.

JSC's New Water Tank

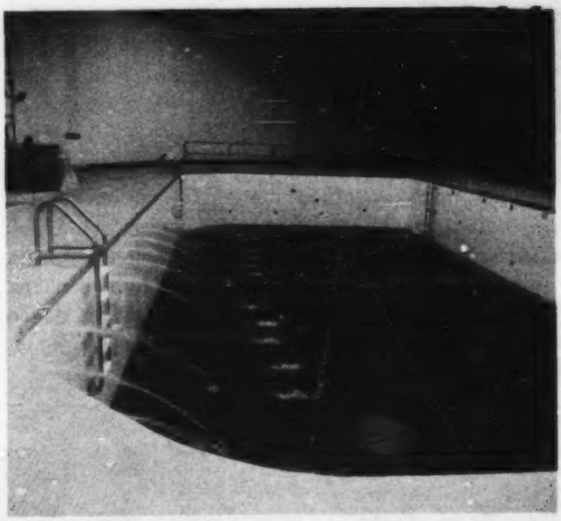
Almost everything about space—hard vacuum, temperature extremes, harsh sunlight—can be simulated on Earth, except the slow-motion weightlessness of space travel. Brief half-minute periods of zero-gravity, or weightlessness, can be duplicated by flying a roller-coaster path in an airplane, but neutral-buoyancy in a water tank is the only way to approximate long periods of weightlessness.

The Johnson Space Center in Houston began using its new water immersion facility (WIF) in October for Space Shuttle crew training. Located in the round building formerly housing the Apollo manned centrifuge, the half-million gallon tank is expected to be valuable in training Shuttle flight crews for spacewalks.

Measuring 33 feet wide, 78 feet long and 25 feet deep, the new WIF holds as much as 25 average backyard swimming pools. It replaces a circular tank 25 feet in diameter and 16 feet deep built in the mid-sixties for Gemini and Apollo emergency water egress training.

JSC and Marshall Space Flight Center will provide WIF training rockups. Marshall will furnish some payload trainers while JSC builds others including a full-size Shuttle Orbiter payload bay.

The WIF filtering and chemical systems reduce bacteria and provide clear water needed in underwater photography. Six submersible TV cameras following training operations—two operated by divers and four mounted under water with pan, tilt, and zoom, manipulated from a console at the pool's edge.



JSC's half-million gallon water tank provides weightlessness training

NASA Mourns Dr. Mutch

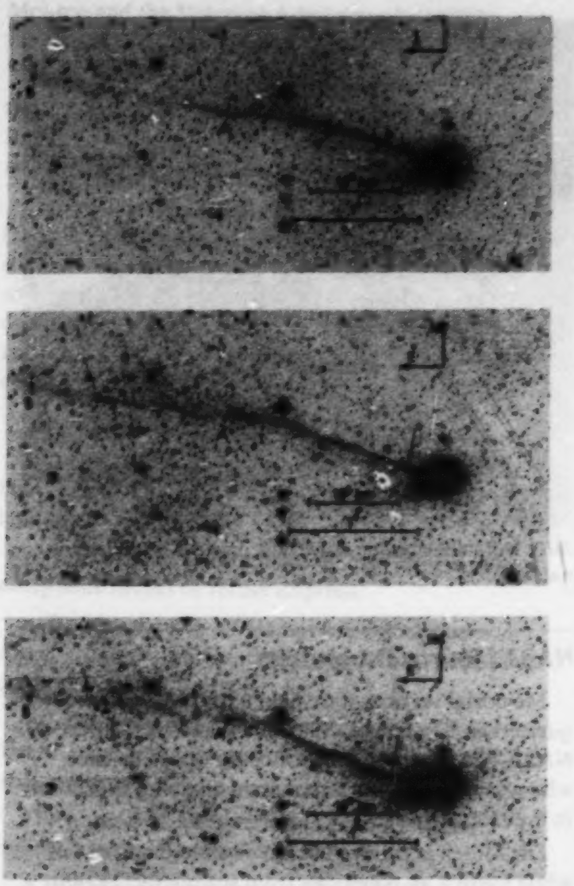
Memorial services were held at NASA headquarters in Washington for Dr. Thomas A. Mutch, 49, NASA Associate Administrator for Space Science, who was killed during a mountain climbing expedition in the Himalayas.

Dr. Mutch is believed to have suffered a fatal fall while leading an American team scaling the 23,000-foot Mount Nun-Run in Kashmir, India, about 350 miles north of New Delhi. Indian officials said the accident took place near the top of the mountain on October 7.

Dr. Mutch became NASA's Associate Administrator for Space Science in 1979, responsible for the planning and direction of the agency's over-all space science program.

He had made major contributions to NASA space science programs since 1969. He was a member of the Lunar Science Review Board from 1969 to 1973, leader of the Viking Lander Imaging Science Team from 1969 to 1977, and he chaired several NASA committees planning the post-Viking exploration of Mars.

Dr. Mutch was awarded NASA's medal for exceptional scientific achievement in 1977. He received the agency's Group Achievement Award three times for his work on the Lunar Science Team, the Viking Science Steering Group, and the Viking Undergraduate Intern Program.



Comet Wags Tail—Investigators for Goddard Space Flight Center obtained the three pictures of Comet Bradfield, while its tail underwent a violent and rapid bending as it passed the Earth last winter. Top picture: the comet just before the tail wagging. Middle: 15.5 minutes in the bend. Bottom: 27.5 minutes later, the bend reaches its fullest displacement. Investigators Dr. John Brandt and Dr. Malcolm Niedner made the observations from the observatory at Socorro, New Mexico, operated for Goddard by the New Mexico Institute of Mining and Technology.

Research Session at AU

A two-day conference begins near Washington on Dec. 10 on "keeping research and development on track", sponsored by the American University's Center for Technology and Administration. NASA participants will include Dr. Enrico P. Mercanti, Goddard Space Flight Center; Donald S. Friedman, Technology Utilization Officer, and H. J. Peake, retired Chief, Office of National Needs, both of Goddard; and David Braustein, Deputy Associate Administrator for Space Transportation Systems.

Special Guest at MSFC—Novelist James A. Michener (left) sits down with Director William R. Lucas of the Marshall center during a recent visit and is briefed on the Shuttle, Spacelab, Space Telescope and materials processing in orbit. A foremost proponent of the space agency and a very vocal advocate of space exploration, Michener is a member of the NASA Advisory Council. Recently, the author narrated and appeared in a film on the Space Shuttle, produced by Filmline Associates for the NASA Motion Picture Office.

Disabled and Honored—George C. Grady (second from right) and his wife Gwendolyn hold his awards as NASA's Outstanding Handicapped Federal Employee of the Year after a ceremony at the Langley center. Richard H. Petersen, Langley Deputy Director (right), and Earl F. Stahl, Chief of the Operations Support Division, made the presentation. Grady was severely injured in 1973 while working in a pressure facility, lost most of the use of his arms and legs, and was declared 95 percent disabled. He insisted on returning to work at Langley, where his experience in high pressure systems overrides his handicap and makes him a valuable technican and instructor.

Satellite Monitors Moth Damage

A three-year pilot program to develop and demonstrate the capability of using Landsat satellite data to detect and monitor gypsy moth damage in East Coast forests has been launched by NASA and the Pennsylvania Department of Environmental Resources.

The gypsy moth caterpillar, which primarily inhabits the northeastern United States, feeds predominantly on the leaves of hardwood trees, such as oak and maple. In 1980 alone, the caterpillars defoliated 178,062 hectares (440,000 acres) of hardwood forests in Pennsylvania. Over the past 10 years, gypsy moth damage to the hardwood forests of the state has been estimated at $32,000,000.

The pilot program employs multispectral scanner data from NASA's Landsat satellites to examine hardwood forests conditions before and after defoliation occurs. This procedure allows forested areas exhibiting gypsy moth damage to be identified and located on the satellite image so that analysis of subsequent imagery can be concentrated on monitoring those areas affected.

Florida Weather Flight—Because the Sunshine State still has its share of violent weather, NASA researchers are testing new detection instruments there by plane. Flight technicians at Patrick AFB are preparing the Johnson center's WB-57F as NASA pilot Al Crews signs the flight checksheet. The aircraft carries a weather-sensing packaging developed by scientists at the Goddard center; at an altitude of 60,000 feet, the instruments will peer down and monitor thunderstorms, hurricanes and other disturbances. When the development instruments are verified, on flights controlled by KSC's Aircraft Operations Section, they are then slated for use as the "eyes" of advanced weather satellites.

Reflections from Earth

NASA's Landsat-2 satellite has captured man's first deliberate attempt to create an image on earth large enough to be recorded from outer space.

The image, a series of mirrors placed in a remote area of California's Mojave Desert, resembling a human eye, was photographed by the satellite in an experiment designed to determine the possibilities of using mirror images on the ground for improved mapmaking.

In addition, the experiment served as a forerunner of what will be a unique phase of Los Angeles' Bicentennial celebration next spring. At that time, reflections from mirrors to be placed by children from thousands of schools and by participants from other organizations will appear on a NASA Landsat image.

The mirrors will be carefully adjusted to reflect the sun into the lens of the satellite at the precise moment its Multiband Scanner records an image of the city. At the time of the satellite pass, a reconnaissance aircraft, made visible to the ground by trailing smoke, will film the event.

The project, called "Reflections from Earth," is a space age educational and festival program. The idea was conceived by Tom Van Sant, Southern California artist and sculptor, who worked closely with NASA and the U.S. Geological Survey to devise this phenomenon. Project Scientist for Landsat, Dr. Stanley Freden, of NASA's Goddard Space Flight Center, is assisting in the project by providing orbital flight information.

It's Supermetal!

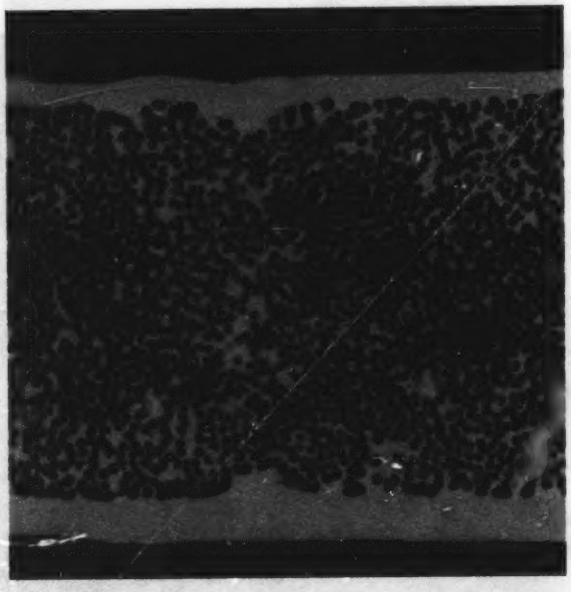
QUESTION: What metal is lighter, stronger and stiffer than aluminum and carries a lifetime guarantee in space?

ANSWER: Supermetal! Aluminum or magnesium laced with thousands of hair-thin strands of graphite fibers. Technically named, "metal-matrix composites," and now a project at the Johnson Center.

Sandwiched between aluminum or magnesium, the feather-light graphite makes the finished materials stronger, about four times more rigid and up to 35 percent lighter. Unlike other metals in space, the composite also provides thermal stability—remaining unaffected by heat or cold since graphite-metal matrix composites will not expand or contract significantly.

Because they resist solar radiation and do not "out gas," they are almost indestructible and should function in space indefinitely, says Glenn M. Ecord, senior metals engineer in the JSC Structures and Mechanics Division.

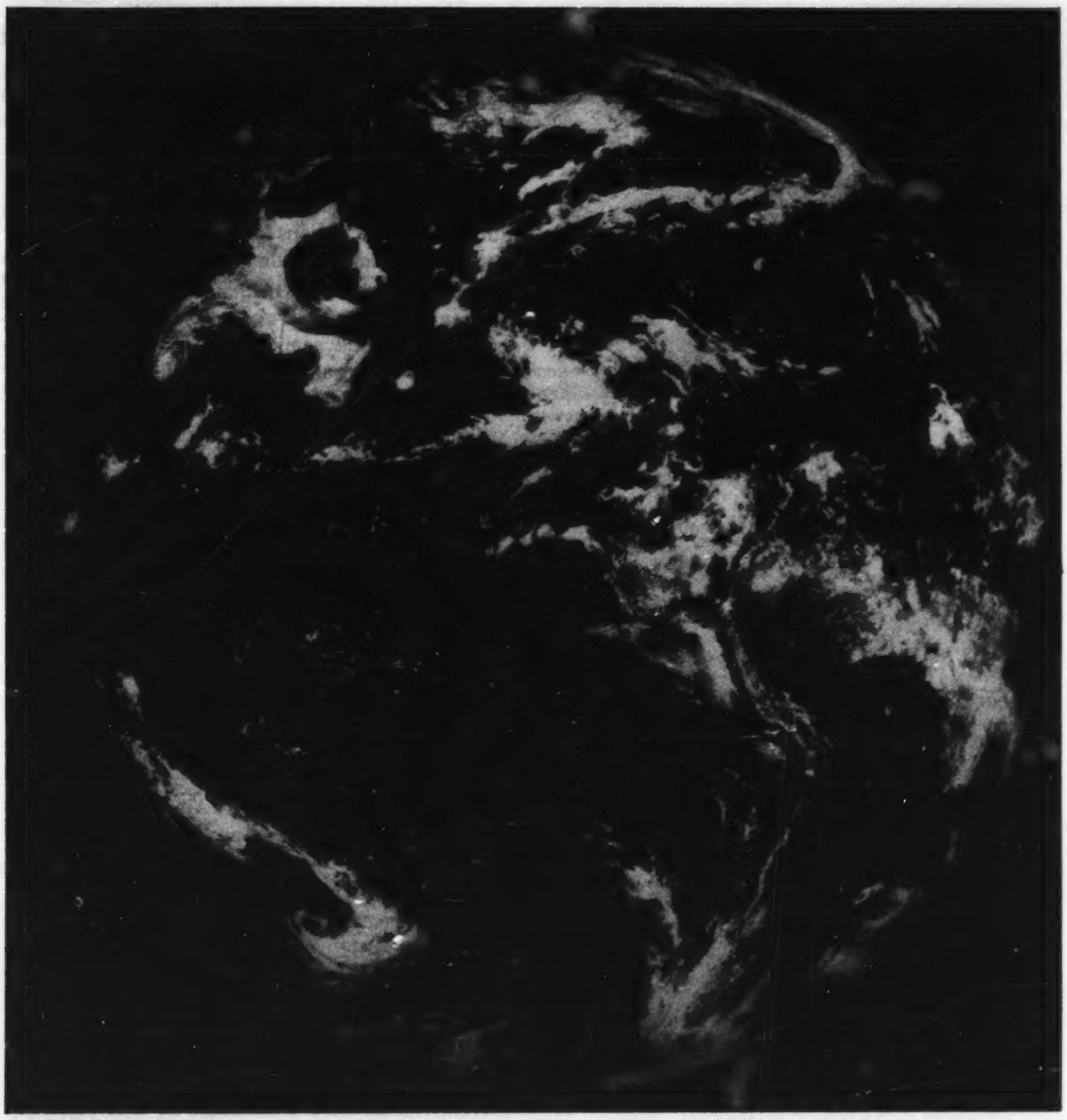
The new supermetals are being developed for space operations of the future. They will be used for large, permanent space structures, antennas, geodetic beams, solar arrays, booms and masts, large mirrors and their supports, and deployable space antennas, according to Ecord.



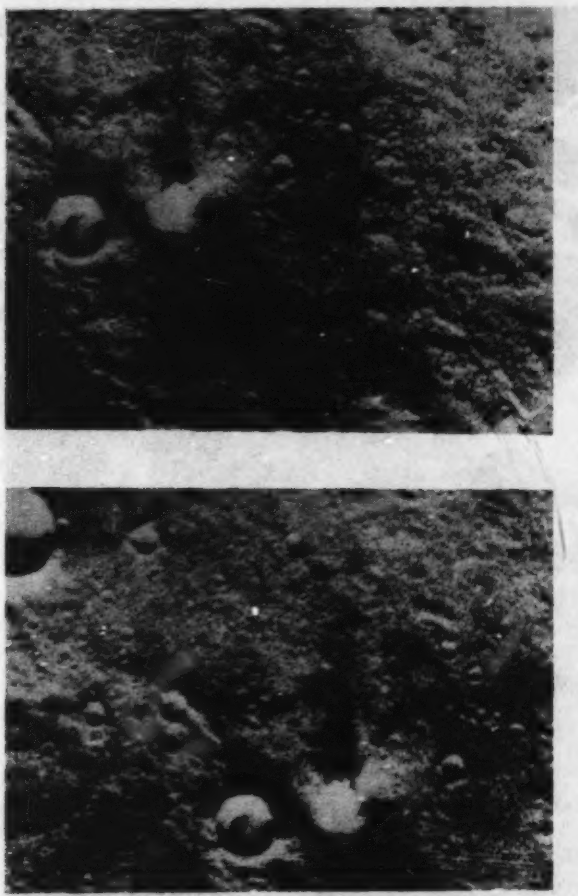
The Super Edge—Magnified 160 times, this end view of a metal matric composite, actually about the thickness of a credit card, shows thousands of dark graphite strands embedded in magnesium. They form a metal light enough and stiff enough for possible use in future space structures.

Supermetal composites also promise to benefit construction, the automobile industry and commercial aircraft with lighter and stronger structures. Although the metal-matrix composite is about 15 years old, aerospace metal specialists about four years ago learned how to produce a high quality material using a special coating to bond the graphite fibers to metal.

First such test hardware is scheduled for delivery by Lockheed to the Johnson Space Center by 1981. Lockheed will provide two wave guides—box-like devices designed to direct microwaves for solar power satellites of the future.



Cloudy Globe by Goes—This is the first cloud cover image taken by the Goes 4 satellite, launched September 9 as the first orbital mission in a joint operational and research project of NASA and the National Oceanic and Atmospheric Administration. The picture shows South America on the right with the United States seen above the center. Over southern Mexico and Honduras is a cyclonic cloud pattern associated with the remnants of Hurricane Hermine. Just south of Baja is another swirl which is a tropical depression that was a storm 12 hours earlier. To the left of this depression is another cyclonic swirl which is Hurricane Kay approaching Hawaii. The cloud pattern extending from the Middle Atlantic states southwest to Texas is the incident stage of a small storm which brought some badly needed rain after the hot, dry summer.



Martian Activity—An unusual cloud formation on the planet Mars was photographed by Viking Orbiter 1 from 500 kilometers altitude on August 1, 1978, and recently interpreted by Dr. Leonard Martin of the Lowell Observatory in Arizona. A small cloud, about 500 meters across, casts a shadow on the surface in the upper picture. In the lower picture, taken just 4½ seconds later, the cloud and its shadow have changed, and Martin says that it might be a column of steam coming from a volcano or a small volcanic event. This is the first suggestion of volcanic activity on Mars.

Contractor News

International Business Machine Corporation, with offices at 7900 N. Astronaut Blvd., Cape Canaveral, has won a modification to an existing contract to provide management and integration support for Space Shuttle payload facilities at the Kennedy Space Center. The modification has a value of almost $13 million. Under the contract, IBM will perform design, development, integration and other services for cargo integration test equipment at KSC; the services involve receiving and assembling cargo integration gear for Space Shuttle payloads.

Teledyne Brown Engineering, of Huntsville, Ala., has been selected for negotiation of a contract dealing with operation and maintenance of propellants and pressurants generating, storage and distribution facilities at the Marshall Space Flight Center. The cost-plus-award-fee contract will be for one year with two one-year options for renewal and the value is estimated to be $4.7 million.

Dynamic Engineering, Inc., of Newsport News, Va., has been awarded a NASA contract for the design and fabrication of dynamic models for use in research and development programs, with the three-year contract managed by Langley Research Center. The cost-plus-fixed-fee agreement, valued at approximately $4.3 million, includes the design, fabrication, calibration and assembly of dynamic scaled aerospace related models, systems and associated support equipment. The models are used primarily for wind tunnel testing.

Martin Marietta Corp., Denver Division, and Aerojet Liquid Rocket Co., Sacramento, Calif., have received supplemental contracts for further program and design definition of a liquid propellant boost module to provide performance augmentation for the Space Shuttle. Value of the Martin Marietta and Aerojet contracts are $1.18 million and $782,500 respectively and they call for the companies to further investigate adaptation of Air Force Titan launch vehicle hardware and production systems to the module.

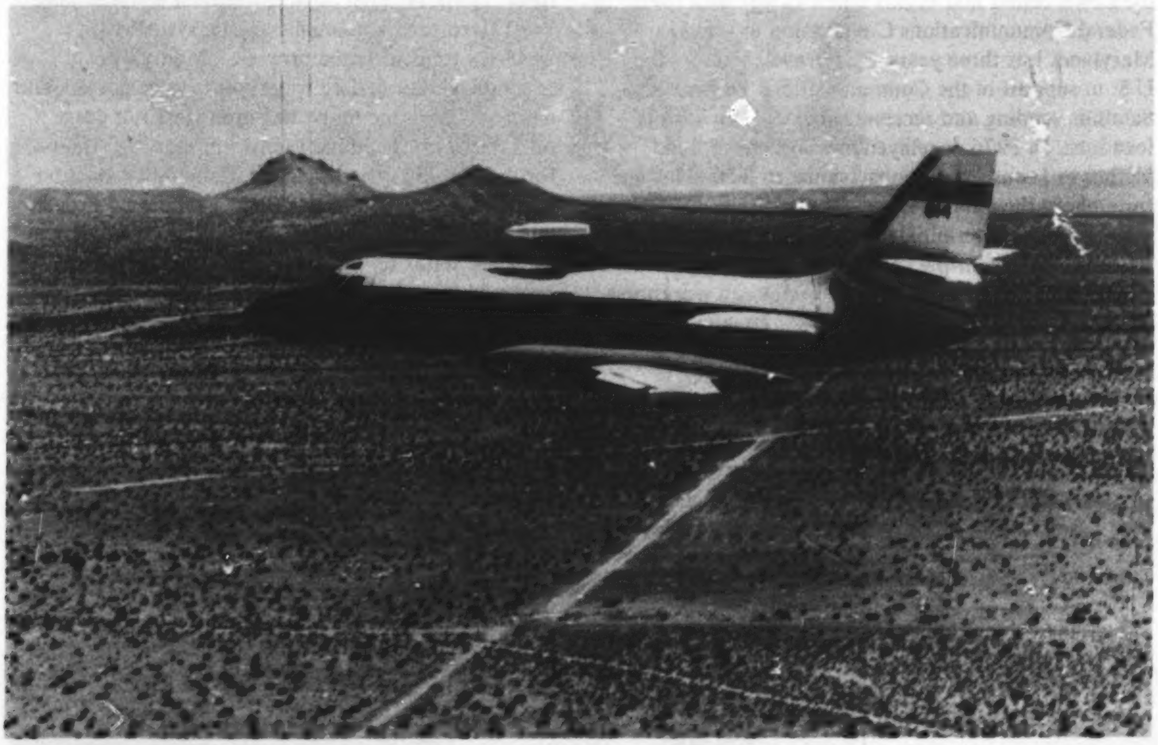
The American Institute of Aeronautics and Astronautics has signed a one-year contract modification for provision of specialized information products in support of NASA's Scientific and Technical Information program. Estimated cost is over $2 million. The work will be performed at the contractor's Technical Information Service Facility in New York.

Huntsville Division of Thiokol Corporation of Utah has been awarded a letter contract for materials for fifty-four solid propellant rocket motors (Castor IVs) plus related spares, due for delivery by October 1, 1982. The value of the contract approximates $4 million. Castor IVs are used as strap-on motors to augment the Delta Space Research Vehicle. Technical direction of the Delta program is performed by Goddard Space Flight Center under the overall direction of the Office of Space Transportation Operations.

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Charles G. Miller, Caltech/JPL, Pasadena.	Underground mineral extraction	4,226,475	NRO/JPL
Louis B. Holdeman, Jaan Toots, Chu-Cheng Chang, National Academy of Science, Washington, D.C.	Microwave integrated circuit for Josephson voltage standards	4,227,096	MSFC
William F. MacGlashan, Caltech/JPL Pasadena.	Power control for hot gas engines	4,228,656	NRO/JPL
Graham C. Shaw, Thiokol Corp., Brigham, Ut.	Recovery of aluminum and binder from composite propellants	4,229,182	NRO/JPL
John A. Wollam, NASA/Lewis	Atomic hydrogen storage method and apparatus	4,229,195	LeRC
Wolf Elber, NASA/Langley	Partial interlaminar separation system for composites	4,229,473	LaRC
James C. Perry, NASA/Goddard	System for displaying at remote station data generated at central station and for powering remote station from central station	4,228,422	GSFC
Patricia A. Brown, San Jose University, San Jose, Calif.	Indomethacin-antihistamine combination for gastric ulceration control	4,230,717	ARC



Airborne Propellor Mount—Flying out of the Dryden center, a specially modified NASA JetStar displays a new pylon atop the fuselage designed to flight test advanced propeller models. The eight and ten bladed props will be smaller versions of the actual new hardware and will be used to study noise levels and fuel consumption. Tests conducted by Lewis Research Center indicate that the propellers could offer up to 40 percent fuel savings over current turbofan engines.

Did You Know?

Makers of the Norden Bombsight, a famous instrument in World War II that was even classed as a "secret weapon", are today heavily involved in aerospace. When the Space Shuttle achieves orbit, the astronauts will be depending on video equipment made by Norden Systems for vital information. Since 1974, Norden, under an IBM award, has designed and produced Orbiter Display Units to give Shuttle crews clear displays of vehicle guidance, control and monitoring data. The Norden firm, founded in 1928, has been widely known for the advanced military electronics systems it provides the U.S. Armed Forces.

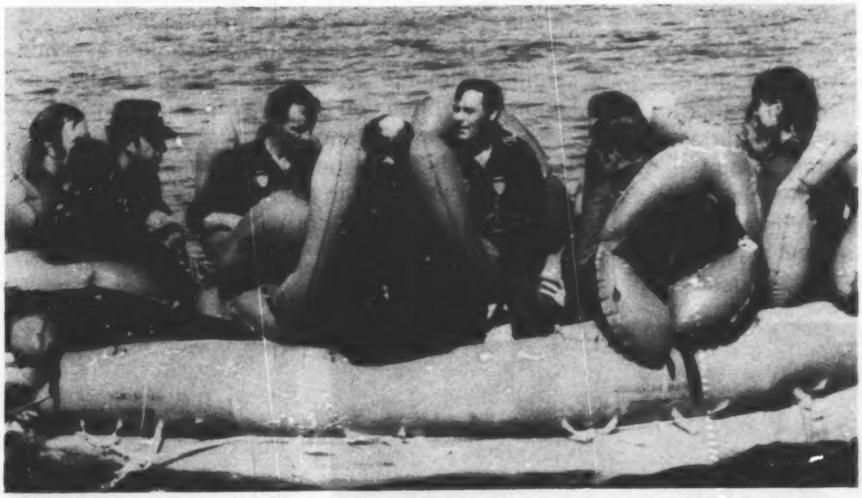
Portable Earth Terminal (PET), a traveling television studio on wheels, has ended its service at the Lewis center and begins a new career with the Federal Communications Commission in Laurel, Maryland. For three years, PET traveled across the U.S. in support of the Communications Technology Satellite, sending and receiving signals from various locations. In 1976. it relayed messages from flood victims in Johnstown, Pennsylvania, to their relatives throughout the nation. When the satellite ended its mission and was terminated, Lewis loaned the 35-foot, instrument-packed bus to FCC.

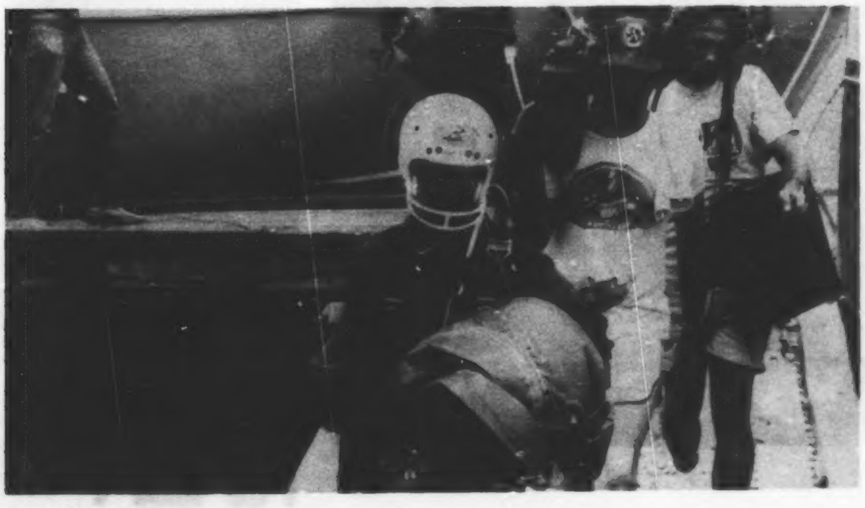
The last Univac 1108 Series computer, a workhorse at the Jet Propulsion Laboratory, has been shut down. Since the first model was installed at JPL in August 1968, the Univacs have provided reliable support, 24 hours a day, for several historic flight projects, notably Viking to Mars and the continuing Voyager mission. The General Purpose Computing Facilities at Pasadena operated as many as three multimillion dollar Univac 1108s at a time but now, said production control chief Robert Coatney, "they have fallen prey to time and the modern state of computer science" and have been replaced by more advanced systems.

Idea Clearinghouse this month cites Goddard Space Flight Center's Facilities Engineering Division for its Work Request Tracking System (WRTS). This is an automated system for tracking the progress of over 800 annual minor design and construction projects, from receipt through payment of final invoice. The WRTS replaced a manual tracking system which was used to identify the progress of individual requests. Under the old way reports to customers and managers took too much time and were not done on a regular basis. Benefits are: improved visibility for the customers and for management, a reduction in the time required to complete a requested project, and the ability to establish appropriate priorities. Monthly status reports of design and construction progress are provided automatically to users, facility managers, and safety representatives.

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January 17	Atlas Centaur	ESMC	DOD Navy. Reimbursable.
SMM-A	February 14	Delta	ESMC	NASA. Scientific Solar Maximum Mission.
NOAA-B	May 29	Atlas-F	WSMC	NOAA Weather. Reimbursable. Launch vehicle failed.
GOES-D	September 9	Delta	ESMC	NOAA Weather. Reimbursable.
FLTSATCOM-D	October 30	Atlas Centaur	ESMC	DOD Navy. Reimbursable.
SBS-A	November 15	Delta	ESMC	Satellite business systems. Reimbursable.
Intelsat V-A	December 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.





The New Breed—For many of the 1980 astronaut candidates, it will be a while before they fly in space. But their demanding training period has begun. In the top picture, the candidates are briefed by Dryden center employee Marta Bohn-Meyers on the Shuttle tile tests, now being conducted in California on F-104 and F-15 aircraft. In the center picture, several of the future astronauts and two European payload specialist candidates are coached in the water survival school at Homestead Air Force Base in Florida. At day's end, bottom picture, candidate for mission specialist Bonnie Dunbar has folded up her individual life raft and leaves the water with a TV camera crew trailing.

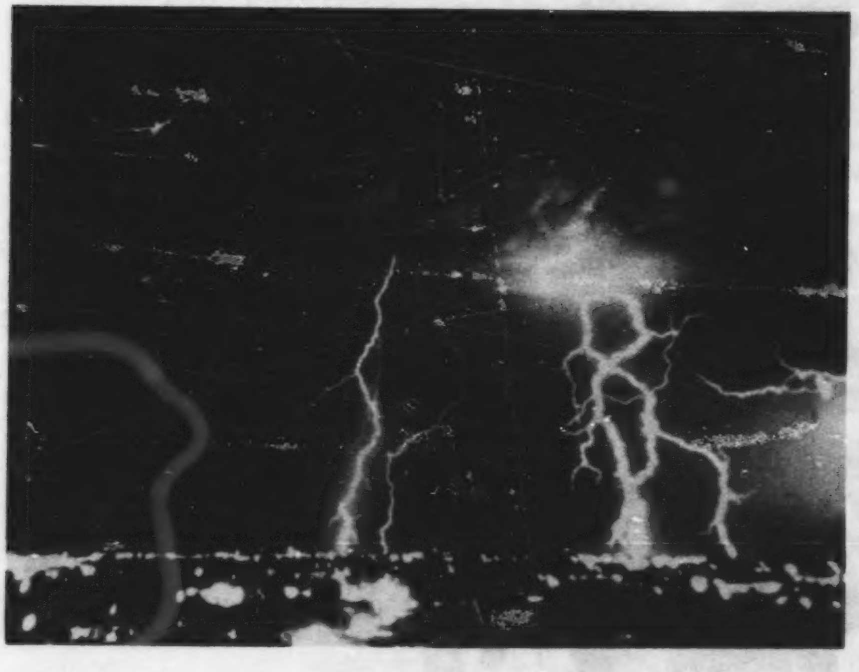
Another Dividend from Air and Space

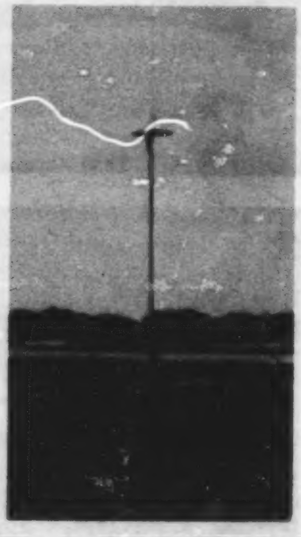
Research and development in aeronautic and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Lightning Detector

The ground antenna pictured is part of the NASA-developed system for pinpointing the location and altitude of lightning activity. The system was devised by the Kennedy Space Center and its original purpose was to give launch controllers additional information on which to base launch or no launch decisions. Called LDAR, for Lightning Detection and Ranging, the receiver system came into being after an incident on an early Apollo Moon mission. A lightning strike, just after launch, knocked out the spacecraft's main electrical and power plant, causing a momentary loss of spacecraft instrumentation, and necessitating a readjustment. As a result, KSC initiated an active program of lightning detection and systems measuring which led to LDAR. It was used developmentally on both the Skylab and Apollo-Soyuz manned missions.

The receivers, with computer processing and display equipment, are sited at points several miles away from a central station. Each receiver picks up signals emitted by electrical discharges in parts of the sky where thunderstorms are building up. The system measures the arrival times of the signals at each station and the computer can then determine the points at which signals originate. Zones of electrical activity are shown as "blips" on a display terminal, which indicates their distance, altitude and bearing. LDAR can indicate the areas of maximum turbulence in a storm. With such precise information, air traffic controllers could route aircraft away from trouble areas.





For the benefit of all . . .

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